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## **Review of the Tortugas Pink Shrimp Fishery from May 1984 to December 1985**

By

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REVIEW OF THE TORTUGAS PINK SHRIMP FISHERY  
FROM MAY 1984 TO DECEMBER 1985

ABSTRACT

Commercial pink shrimp fishing data from the Tortugas fishery were reviewed for biological year 1984 (May 1984-April 1985) and the first 8 months of biological year 1985 (May 1984-December 1985). Pink shrimp landings were just over 11.0 million pounds in biological year 1984 with 17,000 days of fishing expended. This computed to a CPUE value of 643 pounds per day. Pink shrimp landings for biological year 1985 are estimated to be around 9 million pounds with 15,000 days of fishing expended. The predicted CPUE value for 1985 should be around 600 pounds per day.

Biological year 1984 experienced two extended periods of pink shrimp recruitment into the Tortugas fishing grounds. Spring recruitment was from May through July, with winter recruitment running from January through April. Only September has shown any abundance of small recruiting pink shrimp so far during biological year 1985.

The Tortugas sanctuary had a positive impact on the Tortugas, pink shrimp fishery during the 1984 fishing year. Large numbers of small shrimp were caught during biological year 1984 when part of the sanctuary was opened to fishing. Once this area was again closed to fishing, mostly larger sized shrimp were caught. It is therefore our conclusion that the Tortugas sanctuary has met the objectives of the Gulf of Mexico Shrimp Fishery Management Plan to protect small shrimp and thus increase the yield in the Tortugas pink shrimp fishery.

## INTRODUCTION

The Gulf of Mexico Shrimp Fishery Management Plan established an area commonly known as the Tortugas shrimp sanctuary off south Florida in May 1981 (Fig. 1). The concept of the Gulf of Mexico Fishery Management Council in establishing the sanctuary was to protect small, undersized shrimp from being fished and to increase and optimize the overall poundage yield from the fishery. This decision was based on scientific evidence that showed the sanctuary area to be the nursery ground for the Tortugas stocks of the pink shrimp Penaeus duorarum, and that the poundage yield of offshore pink shrimp would be greater if harvest was delayed until shrimp were larger than minimum legal size in Florida (69 tails per pound) (Lindner, 1965; Berry, 1970). Since May 1981, the whole sanctuary has been closed to trawling, with the exception of a small region locally known as the "toe area", which was reopened for a brief period (April 1983 through August 1984) to evaluate the effects (Klima and Patella, 1986).

This paper reviews the characteristics of the Tortugas fishery from May 1984 to December 1985 and compares results with historical data. Deviations from historical averages are discussed in light of the established sanctuary. Current trends with regards to the Tortugas fishery also are discussed.

## METHODS

### Fishery Data Statistics

Collections of detailed catch statistics describing the Gulf of Mexico shrimp fishery in United States waters since 1956 are compiled by and available from the Southeast Fisheries Center (SEFC)/Office of Economics and Statistics (ESO). The procedures used to collect them have been described by Klima (1980). These statistics were used in this report to determine the effects of the Tortugas shrimp sanctuary on the fishery. Catch and effort statistics were grouped and analyzed

by biological year (May through April) for ease of comparing new data with historical data presented in the report. The statistics consisted of catch, recorded as pounds of decapitated shrimp: fishing effort, recorded as 24 hours of actual fishing time: and size composition of catch, expressed in eight "count" or size categories representing number of shrimp per pound with heads off (<15, 15-20, 21-25, 26-30, 31-40, 41-50, 51-67 and >68).

Calculations utilizing these three statistics were conducted in the following manner. The weighted average number of shrimp per pound was calculated by multiplying the pounds landed in each size category by the respective average count. Catch and effort data were used to compile catch per unit effort (CPUE) information, which was expressed as pounds per 24 hours of fishing.

Fishery effort values for 1980 were only crude estimates due to major changes in recording formats. This problem was rectified in 1981, so that fishery effort measurement procedures were identical for the entire data set (1960 through 1984), with the exception of 1980. Therefore, effort values for 1980 were not incorporated into any analyses or depicted on any figures.

### Statistical Tests

Catch data exhibited skewed distributions, showed heteroscedasticity and had non-additive components. Transformations were thus applied to the original data to alleviate these problems and permit valid statistical analysis employing T-tests (Sokal and Rohlf, 1981). Taylor's (1961) test analyzing relationships between means and variances showed that pink shrimp catch and effort data should be transformed logarithmically and CPUE data should be transformed by the inverse of the square root. The analysis of these transformed data provided statistical support to what one could visually determine for the untransformed data. Tests of significance were performed at the 95% level of confidence (Sokal and Rohlf, 1981). All summaries of data are presented with untransformed data.

## RESULTS

### Landings

Annual landings by biological year, May 1960 to April 1984, in statistical subareas 1 through 3, have averaged approximately 9.8 million pounds yearly (Fig. 2). Pounds landed have fluctuated from a high of 13.4 million pounds in 1960 to a low of 6.9 million pounds in 1983. Yet, even with this 6.5 million pound range, the fishery has remained relatively stable throughout this 25 year period. The standard deviation around the historical mean was only + 1.7 million pounds per year, with a value of 18% for the coefficient of variation. Only during biological years 1960, 1965, 1971, 1982 and 1983 have yearly landings fallen outside one standard deviation of the mean. During biological year 1984, over 11 million pounds of pink shrimp were landed from statistical subareas 1 through 3 (Fig. 2). This value was above the historical mean of 9.8 million pounds, but still within standard deviation of the mean.

Although annual landings for all three statistical subareas combined has remained relatively stable over the past 25 years, there has been some changes noted in the different subareas. Landings have always been greatest from subarea 2 (Fig. 3). However, during the past 25 years, annual landings from subarea- 2 have decreased from a high of 92% of total landings during the 1960 through 1971 period to a low of only 64% of total landings during the 1976 through 1979 period. Since the 1981 closure went into effect, the annual percentage of total landings caught from subarea 2 has fluctuated from a value of 79% of total landings in 1981 to a value of 86% of total landings in 1983. During biological year 1984, the value was 65%. The mean value of pounds taken from subarea 2 during the past 25 years was 8.2 million pounds per year, with a standard deviation of + 1.8 million pounds per year (Fig; 4). The coefficient of variation was 22%. The decrease in percentage of total landings noted from subarea 2 over the past 25 years has been compensated for by an increase in percentage of

total landings from both subarea 1 and subarea 3. Landings from subarea 1 have shown only a slight increase since 1976 (Fig. 3). Subarea 3, on the other hand, has shown major changes (Fig. 5). Landings in subarea 3 have increased from a low of 7% of total landings in 1960, to a high of around 33% of total landings during the late 1970's. Since the 1981 closure, the percentage of the total landing taken from subarea 3 has been around 13%. During biological year 1984, the value had increased to 26%. The average poundage taken from subarea 3 during the past 25 years was 1.3 million pounds with a standard deviation of 1.1 million pounds (Fig. 5). The coefficient of variation was 82%.

The monthly pattern of shrimp landings in biological year 1984 and the first 8 months of biological year 1985 (May 1985 through December 1985) were compared with historical monthly averages (Fig. 6). During biological year 1984, May through July catches were greater than average. However, only June and July were significantly different than their historical counterparts. This pattern ended with August, when lower than average landings occurred, and continued through November. None of the poundage values for these four months were significantly below the average historical landing value for that particular month. Peak shrimp landings occurred during December and January. However, landings were significantly greater than average only during December. Pounds landed varied little from monthly historical averages during the latter months of biological year 1984 and the early months of biological year 1985. September 1985 showed a greater than average pounds landed value, but the last three recorded months for biological year 1985 were below average. None of the poundage values for these four months were significantly different than their respective historical average.



### Fishing Effort

Fishing effort by biological year, May 1960 to April 1984, in statistical subareas 1 through 3 has averaged 16,000 days per year with a standard deviation of + 2,300 days per year (Fig. 7). The coefficient of variation was 14%. The small standard deviation and low coefficient of variation are good indicators of the stability of this fishery. Even so, effort has fluctuated from a high of 22,000 days expended in 1960 to a low of only 11,000 days fished in 1979. Fishing effort reported for biological year 1984 was about 17,000 days, which is above average, but still within one standard deviation of the historical mean.

Effort expended in subarea 2 has decreased over the past 25 years, from a value of 96% of total effort in biological year 1961, to a value of 69% of total effort during biological year 1984 (Fig. 8). Even with this noted decrease in effort, a standard deviation of only + 2,800 days was determined for a historical average effort of 14,000 days in subarea 2. This computed to a coefficient of variation of 20%. Effort expended in subarea 3 has risen from values around 3% of total effort in the early 1960's to values around 30% of total effort in the mid to late 1970's (Fig. 9). After the closure in 1981, values declined slightly, with a value of 24% of total effort being obtained during biological year 1984 from subarea 3. The historical average effort expended in subarea 3 has been around 2,000 days, with a standard deviation of about + 1,500 days. The coefficient of variation was 75%.

The monthly pattern of fishing effort in biological year 1984 and the first 8 months of biological year 1985 were compared with historical monthly averages (Fig. 10). Above average fishing effort values were noted during the early months of biological year 1984. However, only effort values from June and July were significantly greater than their respective historical averages. Effort values fell below average during the October through December period of biological year 1984, but none of these values were significantly below average.

During the remainder of biological year 1984 and the first four months of biological year 1985, effort expended during each month fluctuated only slightly around their respective historical mean value. The September 1985 effort value was significantly greater than the historical average for that month. October through December effort values were all below average, but not significantly below.

#### Relative Abundance

The relative abundance of pink shrimp, as expressed by catch per unit effort (CPUE), is reported as pounds caught during a 24 hour fishing day (pounds per day). The annual CPUE at the Tortugas fishing grounds has been a very stable parameter over the last 25 years. CPUE values have averaged a little over 600 pounds per day with a standard deviation of around 80 pounds per day (Fig. 11). This has resulted in a coefficient of variation value of 13%. The highest historical CPUE was close to 800 pounds per day during biological year 1981 and the lowest CPUE was 505 pounds per day, which occurred during biological years 1982 and 1983. The annual CPUE value during biological year , 1984 was a little higher than average at 643 pounds per day.

CPUE values from subarea 2 (Fig. 12) and subarea 3 (Fig. 13) have both been remarkably stable over the past 25 years. The historical average at subarea 2 was 590 pounds per day with a standard deviation of + 80 pounds per day (coefficient of variation was 14%). Similar results were found at subarea 3 with a historical average of 608 pounds per day and a standard deviation of + 99 pounds per day (coefficient of variation was 16%).

Even though annual CPUE values for the past 25 years have not varied considerably, large variations have been noted in monthly CPUE values (Klima et al., 1986). Thus, a large standard deviation value is found around each monthly historical mean CPUE value. Monthly CPUE values for biological year 1984 and the first 8 mnths of biological year 1985 were compared with their respective monthly historical mean value (Fig. 14). All months, except four during biological year

1984, had remarkably similar CPUE values compared with their historical average. The exceptions were September and October, with below average values, and May and December, with above average CPUE values. However, only May and December differed significantly from their respective historical average CPUE value. Large standard deviations during the other two months prevented statistical significance of values.

In comparing the monthly CPUE values with the historical data, we also plotted a ratio of the monthly CPUE values from May 1981 through December 1985 over the historical monthly CPUE values (Fig. 15). These data showed that for the brief period the toe area was opened during biological year 1984, CPUE values were high in comparison to historical values. Fishermen seemed to be taking advantage of the numerous small shrimp in the area. CPUE values for biological year 1984 were again high in comparison to historical values during December and January. Many large shrimp were discovered and caught on the Tortugas grounds during this period. During the remainder of biological year 1984 and the first 8 months of biological year 1985, monthly CPUE values were near average.

### Recruitment

Recruitment of pink shrimp onto the Tortugas fishing grounds usually occurs during two periods in a calendar year. The first recruitment takes place from March through May, with a second recruitment from August through October. In the past, the pounds of pink shrimp landed and the average size of pink shrimp measured by the size categories of the ESO have been used as an indicator of recruitment on the Tortugas grounds during certain months (Klima et al., 1986). Specifically, if the landings for a selected month exceeded the historical average and if the average weighted mean size for that month was greater than the historical average, the recruitment was termed "good" or "better than average" for that month (Table 1). Although this method showed correlation between good recruitment and

above average landings in some years, in most cases it failed to show any correlation. Either good recruitment with poor catch was noted, or lack of recruitment was shown during a year with an outstanding catch. Take the examples of biological years 1983 and 1984. Analysis of data in Table 1 reveals that recruitment appeared "better than average" during March through April of biological year 1982 and during May of biological year 1983. One would have expected an average or above average catch during biological year 1983. Yet, biological year 1983 had an extremely low poundage of pink shrimp caught. Biological year 1984 was above average with regards to pounds of shrimp caught, but Table 1 reveals only two months of recruitment.

Utilization of landing data by size class composition, as stated above, is the best method to show recruitment into the fishery, but all months must be analyzed to draw correct conclusions from the data. Analysis of data may be shown as either percent composition of each size class, or just expressed as actual pounds caught by size class. With either method, recruitment is indicated whenever a high percentage of the catch or a large poundage figure is in size class group number 8 (> 68 tails per pound). However, when using percent composition figures to determine recruitment, caution must be used in interpretation of results. Data expressed as percent composition by size classes must not only be carefully correlated with actual pounds caught to determine intensity of recruitment, but it must also be checked to determine if recruitment was masked by high percentage values in other size classes.

According to analysis by percent composition of each size class, the Tortugas fishery seemed to have experienced some type of recruitment in biological year 1984 during May, June, July, and possibly August and April (Fig. 16). Thus, according to this analysis, peak spring recruitment was delayed and winter recruitment was absent in biological year 1984. Only September has shown strong recruitment thus far in biological year 1985.

Periods where recruitment has occurred were easily observed when

analysis was performed by actual pounds caught for a given size class (Fig. 17). Recruitment periods in biological year 1984 were May through July and January through April. Note that the recruitment shown to occur with this analysis during the late winter months was masked in the percent composition analysis by the great percentage values in large size classes. The only recruitment that has occurred thus far in biological year 1985 seems to be in September and maybe October.

Pounds caught for a given size class were next analyzed by each subarea separately. Subarea 1 contributed minor recruitment to the Tortugas fishery (Fig. 18). Small impulses of recruitment were noted in May and February through April during-biological year 1984. In subarea 3, no periods of recruitment were noted (Fig. 19). The majority of the recruitment of shrimp onto the Tortugas grounds was from subarea 2 (Fig. 20). Major periods of recruitment were noted during May through July and January through April in biological year 1984 and in May and September of biological year 1985. Periods of minor recruitment were noted during October through December in biological year 1984 and during October in biological year 1985.

### Size

The size of shrimp landed may be used to identify change that may have occurred due to fishing. If the management measure of prohibiting trawling in the sanctuary was effective and restricted the capture of small shrimp, we would expect the size of shrimp to increase and therefore be different than the historical average sizes. During the first four months of biological year 1984, part of the Tortugas sanctuary (the toe area) was opened to fishing for comparative purposes (Klima and Patella, 1986). This allowed fisherman to catch some shrimp that would have been protected by the sanctuary under normal circumstances. During the period this area was opened to fishing, many small shrimp were caught (Table 2). Once this area was closed again, mean number of shrimp per pound decreased abruptly. Thus,

small shrimp (50-60 count) were caught in great abundance from May through August of biological year 1984, while larger sized shrimp (35-45 count) were caught thereafter (Fig. 21). Many small shrimp also were caught in September 1985, when they moved onto the grounds from the sanctuary during normal recruitment migration.

## DISCUSSION

The Tortugas fishery has been very stable over the past 25 years. Evaluation of annual historical data showed very low coefficient of variation values for landings (18%), fishing effort (14%), and CPUE (13%). The fishery is bounded naturally by untrawlable bottoms of loggerhead sponges and coral reefs where pink shrimp are protected from trawling activities, even though they may be present in high concentrations. This large area of untrawlable bottom surrounding the fishery grounds may be one reason why this fishery has been so stable since 1960.

During biological year 1984, all three catch statistic values were above their respective historical average. Pounds of shrimp landed were around 11.0 million pounds, with a fishing effort value of about 17,000 days. This computed to a CPUE value of 643 pounds per day fished. Even though each of the three catch statistics was above average, none were significantly above average. As shown in previous years, most pink shrimp were caught in relatively shallow water (Fig. 22).

Annual landings and fishing effort values were both highest from subarea 2, when all three subareas were evaluated separately. It appeared from the data that during biological year 1984 and the first 8 months of biological year 1985, only large shrimp were taken in subarea 3 (Fig. 19), and only newly recruited small shrimp were caught in subarea 1 (Fig. 18). Small shrimp migrate onto the fishery from the east and move first into fishable areas of subarea 1 and subarea 2 (Gitschlag, 1986). If these shrimp are not quickly caught as they enter the fishery, migration will take some shrimp size classes northward into subarea 3 (Gitschlag, 1986). This might explain why high production levels in subarea 3 occur mostly

during years of peak shrimp abundance (Fig. 3). If overall shrimp recruitment is low to moderate, then most shrimp would be caught in subarea 2 where they concentrate before some move into subarea 3. If shrimp recruitment is above average for a given year, then high enough concentrations of shrimp, to make it worth the effort to catch them, move into subarea 3.

This phenomenon is also supported from data gathered over a shorter time frame than a year. During November 1984, 40-60 count shrimp began to move into subarea 2 (Little<sup>1</sup>). These shrimp were probably from the early spring recruitment of shrimp that had stayed inside the sanctuary line until November (Klima and Patella, 1986). Although these shrimp were fished upon in subarea 2 during the last few weeks of November through the first week or two of January (Fig. 20), enough shrimp moved northward into subarea 3 to provide a suitable concentration to be fished upon during December and January (Fig. 19).

The offshore pink shrimp fishery discussed thus far is directly dependent on young shrimp migrating in large numbers from nursery areas onto the fishing grounds. If these small shrimp are caught early, maximum yield in the fishery is not attained. The permanent closure of the Tortugas sanctuary was established in May 1981 to prevent the capture of these-small shrimp in the nursery areas and thus maximize the yield. As stated earlier, the whole sanctuary has been closed to trawling since that time, with the exception of the toe area, which was reopened for a brief period (April 1983 through August 1984) to evaluate the effects. A report by Klima and Patella (1986) showed an increase in the number of small shrimp caught during the period the toe area was opened. With the reclosure of the entire sanctuary to shrimping activities, size ratio values (average monthly size divided by historical monthly size) have again decreased (Fig. 23). Small shrimp being recruited to the offshore fishery were rapidly

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<sup>1</sup>Edward J. Little, Jr., Personnel Communication, National Marine Fisheries Service, Office and Custom House Bldg.; P. O. Box 269, Key West, FL 33040.

harvested when the toe area was opened, but small shrimp were able to increase in size and then enter the fishery when the toe area was closed (Table 2). Thus, the overall objectives of the closure, to increase the size and optimize the yield of the shrimp moving onto the fishing grounds by preventing the capture of small shrimp in the nursery areas, seems to have been met with the Tortugas sanctuary.

Vessel homeport statistics were analyzed for biological year 1984 (Table 3). During summer and fall months (July through Navetier) the Tortugas fleet was composed mainly of vessels from Florida and the East Coast. Vessels from most other Gulf coast states were fishing off Texas or Louisiana during this period (Klima et al., 1985). When pink shrimp concentrations on the Tortugas grounds increased during the winter and spring months (December through April), the Tortugas fleet composition was mainly formed of vessels from three states. Most of the vessels were from Florida, but vessels from Alabama and Texas increased in numbers.

Illegal trawling inside the Tortugas sanctuary continued to be a problem during biological year 1984. Although only 22 boats were ticketed during calendar year 1985 (Perry Allen<sup>2</sup>; Dale Quick<sup>3</sup>) noncompliance was believed by fishermen to be high. Crude guesstimates of noncompliance range from 30 to 50 percent. However, Perry Allen<sup>2</sup> informed us that enforcement patrols conducted from October 1984 through March 1985 indicated only one suspected violation per every eight hours of observation and for every 17 hours of patrol, one citation was issued. Therefore, the noncompliance as perceived by the fishermen does not appear to be excessively high. Further, in the latter part of 1985 a new enforcement vessel came on line and Mr. Allen believes that violations have decreased appreciably with the increased enforcement capability. Obviously, violations

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<sup>2</sup>Perry Allen, Personal Communication, Southeast Regional Office, Law Enforcement Group, 9450 Koger Blvd., St. Petersburg, FL 33702.

<sup>3</sup>Dale Quick, Personal Communication, Florida State Enforcement Office, Tallahassee, FL 32301.



did occur and may impact the effectiveness of the management measure, but they are less than that perceived by some fishermen.

Above average, but late spring recruitment (May through July) and continued recruitment during the winter and spring months (December through April) of biological year 1984 resulted in an above average catch of pink shrimp. The outlook for biological year 1985 is difficult to determine. Although spring recruitment into the fishery was good, three tropical cyclones, during the summer and fall months, disrupted fishing somewhat. Fall recruitment was extremely poor, with only the month of September showing any concentrations. Thus, unless good recruitment was experienced during the winter months, biological year 1985 may be below average in poundage of pink shrimp landed.

## SUMMARY

1. Commercial pink shrimp landings from the Tortugas fishery (statistical subareas 1 through 3) have been relatively stable for the past 25 years. Average catch has been 9.8 million pounds per year with a standard deviation of + 1.7 million pounds per year. Pink shrimp landings during biological year 1984 were just over 11.0 million pounds. During the first 8 months of biological year 1985 (May through December), 4,562,854 pounds were landed. This value represents a 19% decrease when compared to the first 8 months of biological year 1984, which had 5,662,331 pounds landed.
2. Fishing effort for pink shrimp on the Tortugas grounds have averaged 16,000 days annually for the past 25 years with a standard deviation of + 2,300 days. During biological year 1984, 17,000 days of fishing were expended in the Tortugas fishery. For the first 8 months of biological year 1985 (May through December), effort was 7,158 days. This value represents a 13% decrease in effort when compared to the first 8 months of biological year 1984, which had an effort value of 8,271 days.
3. CPUE (pounds per day fishing) has been the most stable parameter over the past 25 years at the Tortugas fishing area. The historical average has been 600 pounds per day with a standard deviation of only + 80 pounds per day. The CPUE value for biological year 1984 was 643 pounds per day. During the first 8 months of biological year 1985 (May through December), CPUE was 638 pounds per day. This value represents a decrease of only 7% when compared to a value of 685 pounds per day for the first 8 months of biological year 1984.
4. Two extended periods of recruitment of small pink shrimp into the Tortugas fishing grounds were noted during biological year 1984. Spring recruitment was from May through July, with winter recruitment running from January through April.

5. Peak shrimp production was noted during December 1984 and January 1985. Almost 4 million pounds of large shrimp were caught in this 2 month period during biological year 1984.
6. The area locally known as the toe , which was opened to fishing in April 1983, was closed again in August 1984. Thus, for four months during biological year 1984, fishing was conducted in this prima area. Size ratio comparisons showed that many small shrimp were caught when the toe area was opened, but mostly larger shrimp were caught when the area was closed. Allowing fishing in the toe area defeated the purpose of the Tortugas sanctuary,. because small recruiting shrimp were caught before they could grow and enter the offshore fishery at a larger size. Maximum yield in the fishery can not be achieved if the toe area is fished.
7. Illegal trawling inside the Tortugas sanctuary was still viewed as a problem during biological year 1984. Most ticketed boats were found fishing in the toe area of the Sanctuary. A greater yield in the fishery could be gained if this activity was curtailed.
8. During biological year 1984 the Tortugas sanctuary had a positive impact on the Tortugas fishery. Larger numbers of smaller count shrimp (larger shrimp) were caught during biological year 1984, when compared to the historical average/ once the toe area was closed to fishing. The monthly average shrimp size was larger, when compared to historical monthly shrimp size, for all months except September 1985. This indicates that the closure restricts the capture of small shrimp.
9. We conclude that the Tortugas closure has met the objectives of the Gulf of Mexico Shrimp Fishery Management Plan to protect small shrimp and thus increase yield in the Tortugas pink shrimp fishery.

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Table 1. Monthly index of recruitment on the Tortugas fishery grounds using average weight, size count and commercial landings.  
A plus indicates better than average recruitment.

Biological Year	Month						
	May	Aug	Sept	Oct	Nov	Mar	Apr
1960	+	+	+	+		+	
1961		+	+	+	+		
1962						+	+
1963							
1964		+	+				
1965		+	+	+	+		
1966		+	+	+	+		
1967							
1968			+				
1969						+	+
1970	+						
1971							
1972							
1973		+					
1974							
1975		+					
1976							+
1977						+	+
1978	+						
1979		+	+				
1980			+			+	+
1981	+						
1982		+				+	+
1983	+						+
1984	+		+				
1985			+			no data	

Table 2. Monthly average weighted number of pink shrimp per pound for 1960-79, 1981, 1982, 1983, 1984 and 1985 (+ indicates larger size group and - indicates smaller size group than historical average; bracketed portion indicates open fishing in toe of the boot).

Months	1960-1979		1981	1982
	Average Number/lb	Standard Deviation	Average Number/lb	Average Number/lb
May	46.8	5.1	57.4 +	48.4 +
June	45.2	4.5	52.7 +	45.7 +
July	44.0	4.7	44.2 +	36.6 -
August	44.0	7.7	38.9 -	55.0 +
September	48.7	7.9	47.5 -	49.0 +
October	47.9	4.8	41.4 -	43.3 -
November	43.1	3.3	36.4 -	41.3 -
December	40.2	2.8	34.9 -	39.3 -
January	40.2	3.1	35.6 -	43.6 +
February	42.7	3.1	42.1 -	48.0 +
March	47.5	4.4	46.8 -	57.5 +
April	48.3	5.8	49.8 +	54.1 +

Months	1983	1984	1985
	Average Number/lb	Average Number/lb	Average Number/lb
May	56.8 +	55.9 +	42.4 -
June	50.2 +	53.1 +	42.1 -
July	58.0 +	55.0 +	42.1 -
August	49.6 +	46.9 +	33.5 -
September	44.2 -	36.9 -	55.3 +
October	44.0 -	45.8 -	45.9 -
November	36.6 -	41.0 -	33.0 -
December	36.1 -	35.2 -	35.6 -
January	49.4 +	38.0 -	
February	48.1 +	39.8 -	
March	58.7 +	40.5 -	
April	60.5 +	44.2 -	

Table 3. Home port breakdown of Tortugas fishing fleet by percentage during biological year 1984.

Home Port	M	J	J	A	S	O	N	D	J	F	M	A
Florida	69	73	79	80	84	85	84	76	70	67	66	69
Alabama	6	2	5	0	2	2	3	2	6	9	11	11
Mississippi	0	0	0	0	0	0	0	0	0	0	0	0
Louisiana	1	0	1	1	1	1	0	1	1	1	1	1
Texas	7	7	1	3	2	3	2	10	9	10	10	9
East Coast	4	4	1	4	4	3	3	3	3	4	2	3
Unknown	13	14	13	12	7	6	8	8	11	9	10	7

## FIGURE LEGENDS

- Figure 1. Map of the Tortugas fishing grounds and statistical subareas.
- Figure 2. Annual pink shrimp landings from the Tortugas grounds (statistical subareas 1 through 3) for biological years 1960 through 1984. Solid line is the historical mean and each broken line is one standard deviation from the mean.
- Figure 3. Cumulative landings of pink shrimp landed (subareas 1 through 3) for biological years 1960 through 1984.
- Figure 4. Annual pink shrimp landings (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean.
- Figure 5. Annual pink shrimp landings, from (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean.
- Figure 6. Average monthly historical catch compared to the catch from May 1984 through December 1985 taken on the Tortugas grounds (subareas 1 through 3).
- Figure 7. Pink shrimp fishery effort on the Tortugas grounds (subareas 1 through 3) for biological years 1960 through 1984. Solid line is the mean fishing effort and each broken line is one standard deviation from the mean.
- Figure 8. Pink shrimp fishing effort (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean value.
- Figure 9. Pink shrimp fishing effort (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean value.



- Figure 10. Average monthly historical effort compared to the monthly efforts for May 1984 through December 1985 from the Tortugas grounds.
- Figure 11. Catch per unit effort (CPUE) for biological years 1960 through 1984 (subareas 1 through 3). Solid line is the historical mean and each broken line is one standard deviation from the mean.
- Figure 12. Pink shrimp CPUE (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean value.
- Figure 13. Pink shrimp CPUE (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean value.
- Figure 14. Average monthly historical CPUE values compared to the monthly CPUE values for May 1984 through December 1985 from the Tortugas grounds.
- Figure 15. Ratios of monthly CPUE values from May 1981 through December 1985 compared with monthly historical CPUE values (1960 through 1979).
- Figure 16. Percent composition of monthly pink shrimp size classes from the Tortugas fishery for May 1984 through December 1985.
- Figure 17. Total monthly catch by size classes from the Tortugas fishery (subareas 1 through 3) for May 1984 through December 1985.
- Figure 18. Total monthly catch by size classes (subarea 1) for May 1984 through December 1985.

Figure 19. Total monthly catch by size classes (subarea 3) for May 1984 through December 1985.

Figure 20. Total monthly catch by size classes (subarea 2) for May 1984 through December 1985.

Figure 21. Mean number of pink shrimp per pound for a given month. Period covers biological year 1984 through the first 8 months of biological year 1985.

Figure 22. Pink shrimp catch by fathom zones for each statistical subarea (1 through 3) by month (May 1984 through December 1985).

Figure 23. Ratios of monthly mean number of pink shrimp per pound from May 1981 through December 1985 to monthly historical mean number of pink shrimp per pound for 1960 through 1979.

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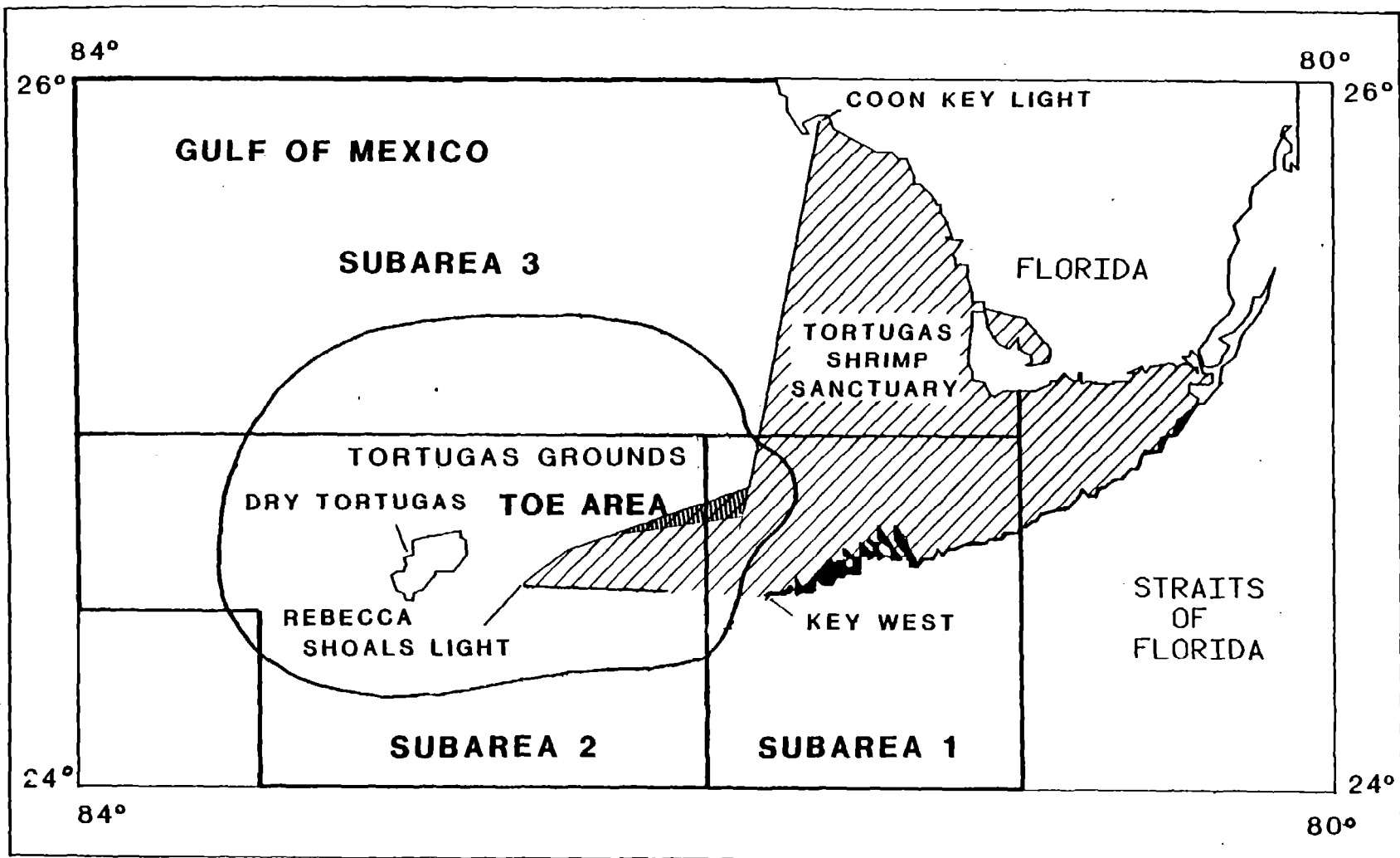


Figure 1. Map of the Tortugas fishing grounds and statistical subareas.

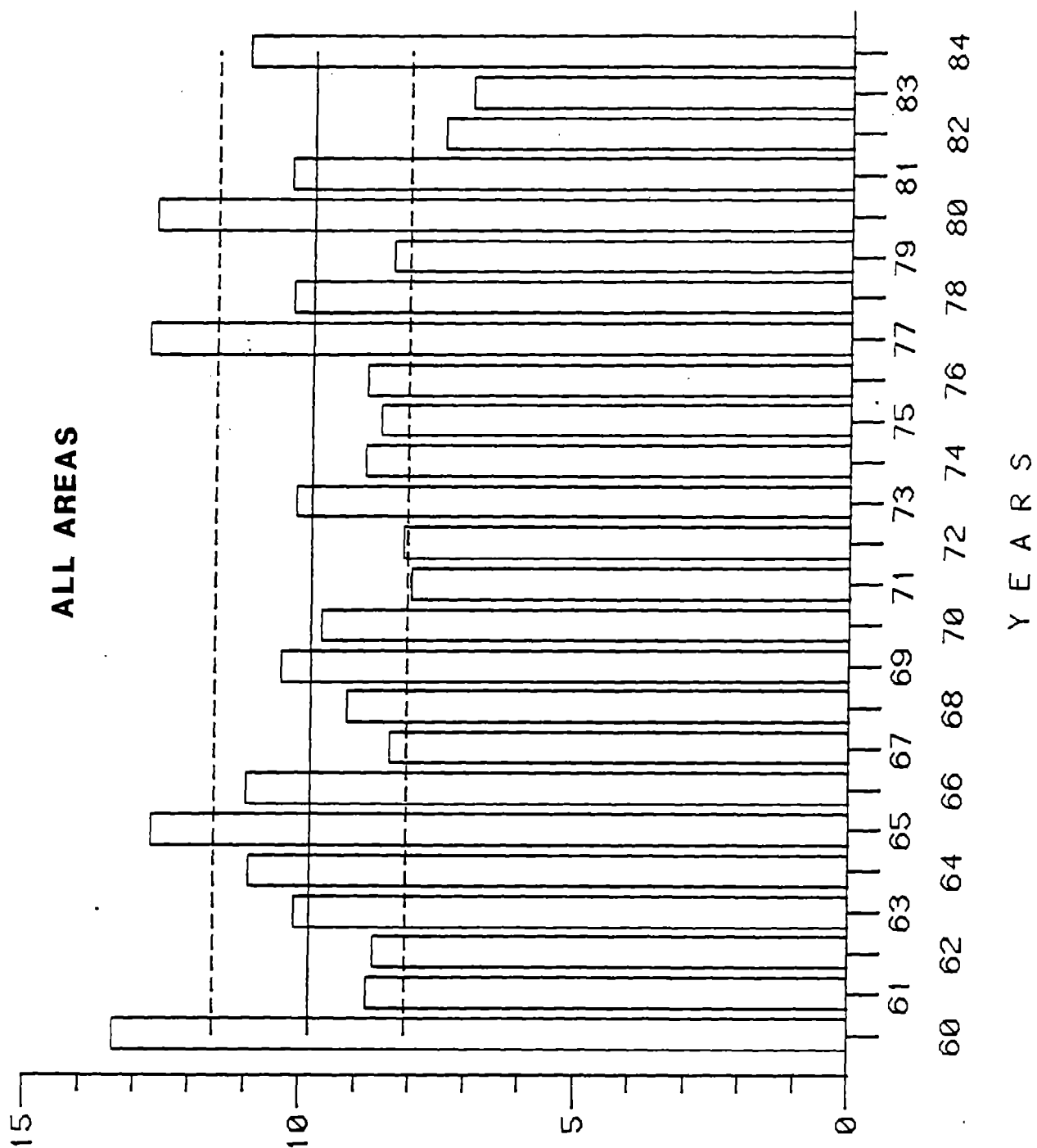


Figure 2. Annual pink shrimp landings from the Tortugas grounds (statistical subareas 1 through 3) for biological years 1960 through 1984. Solid line is the historical mean and each broken line is one standard deviation from the mean.

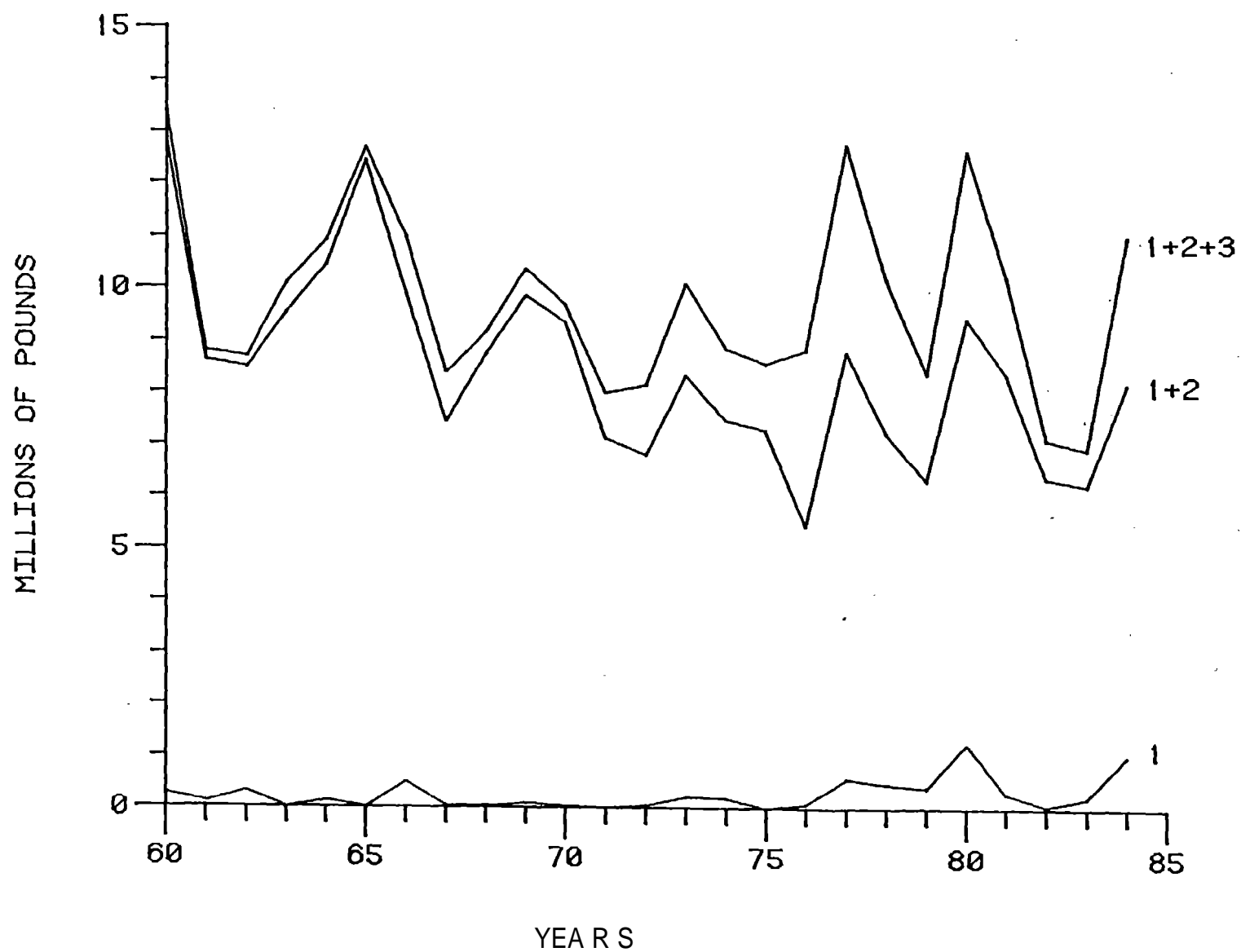


Figure 3. Cumulative landings of pink shrimp landed (subareas 1 through 3) for biological years 1960 through 1984.

TORTUGAS PINK SHRIMP  
SSA 2 ONLY

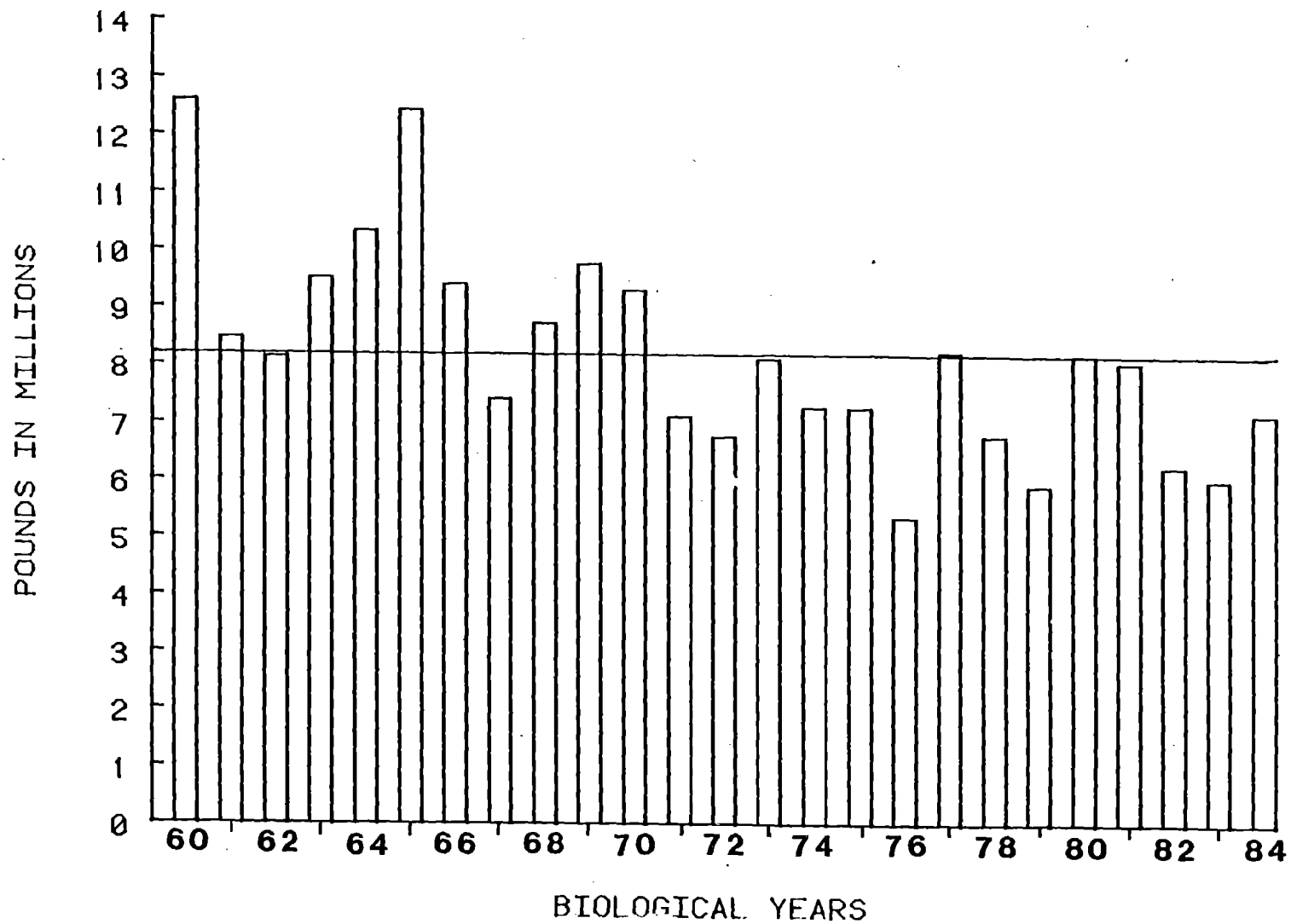


Figure 4. Annual pink shrimp landings (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean.

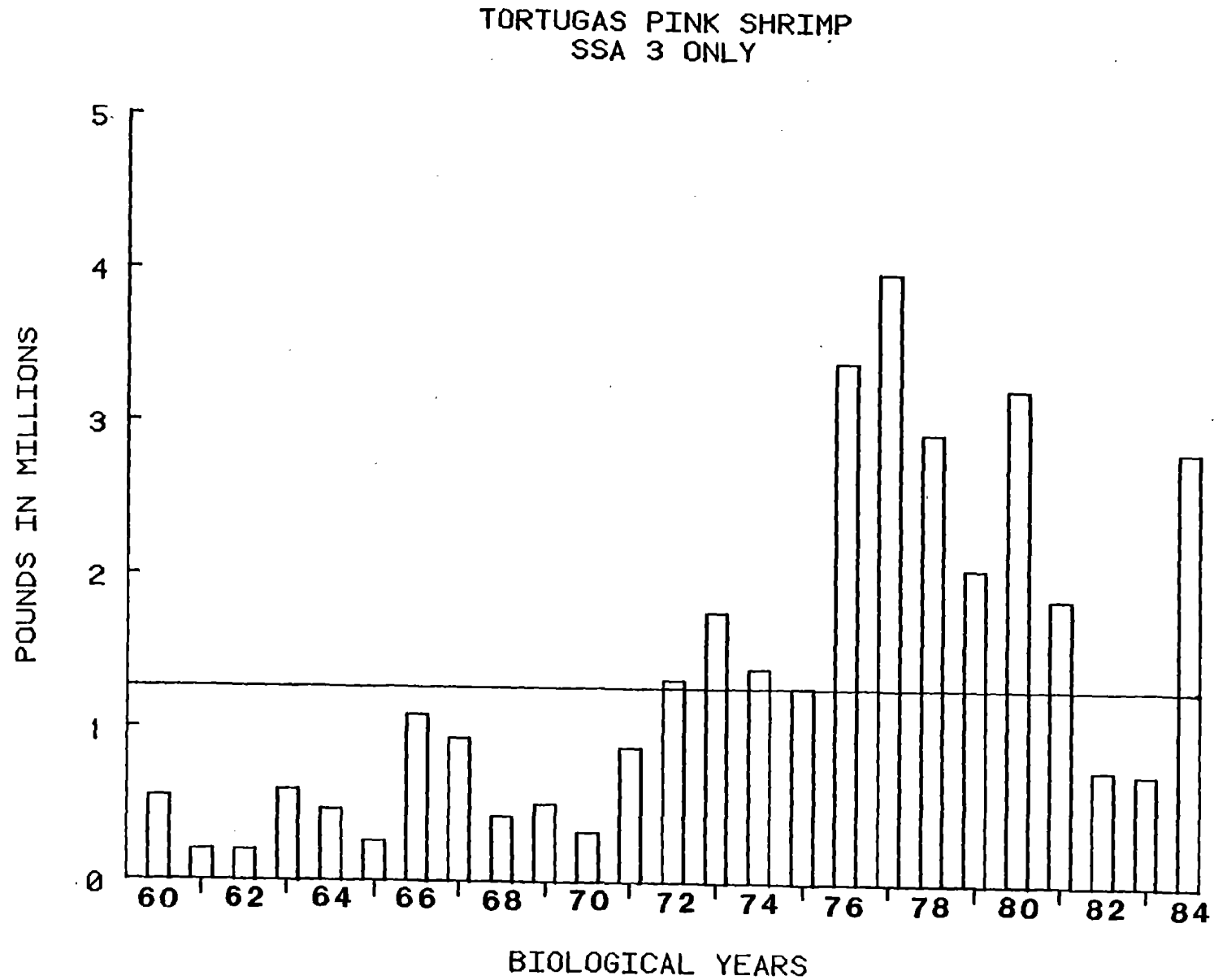


Figure 5. Annual pink shrimp landings, from (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean.

# PINK SHRIMP DATA

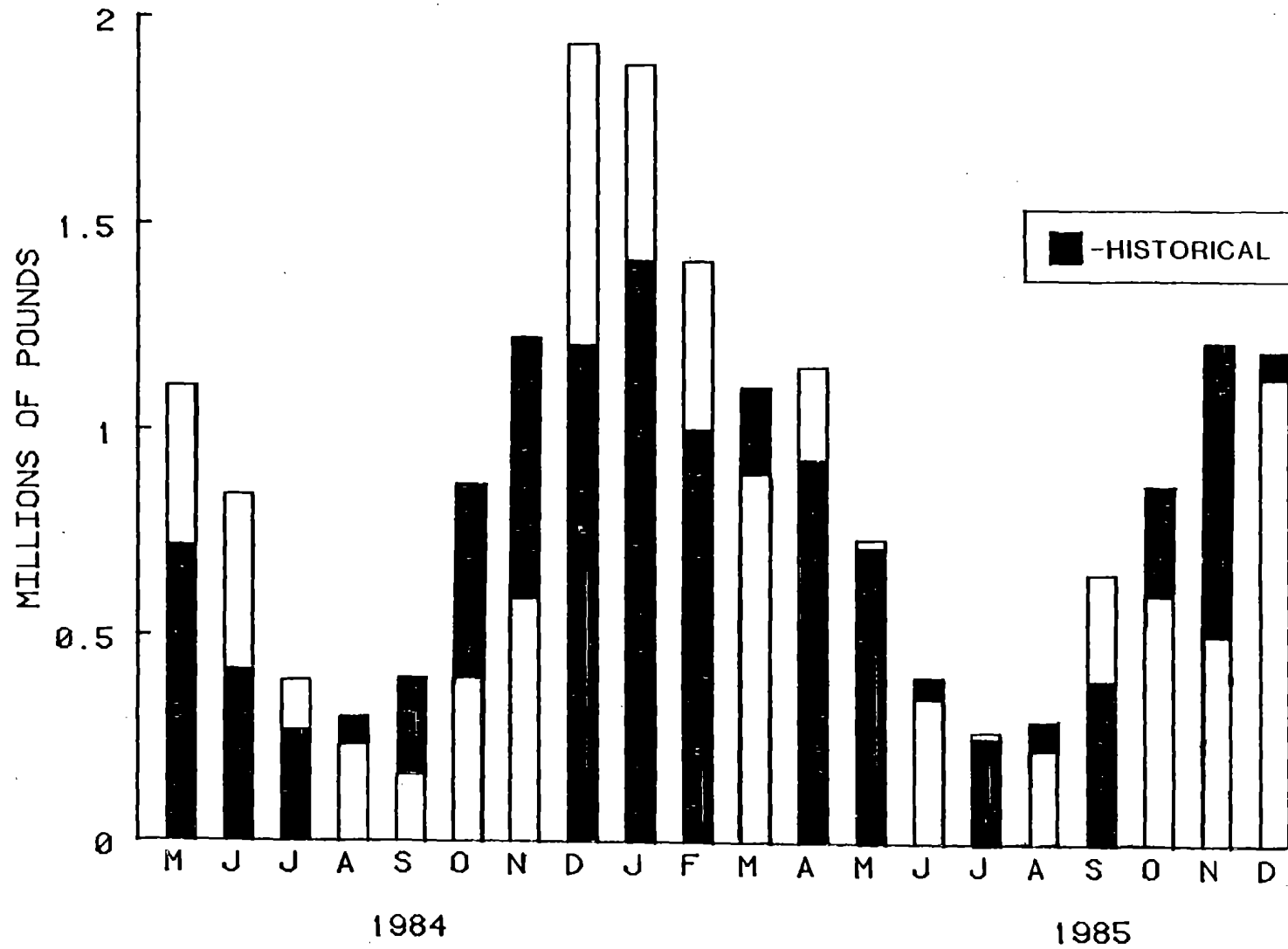


Figure 6. Average monthly historical catch compared to the catch from May 1984 through December 1985 taken on the Tortugas grounds (subareas 1 through 3).



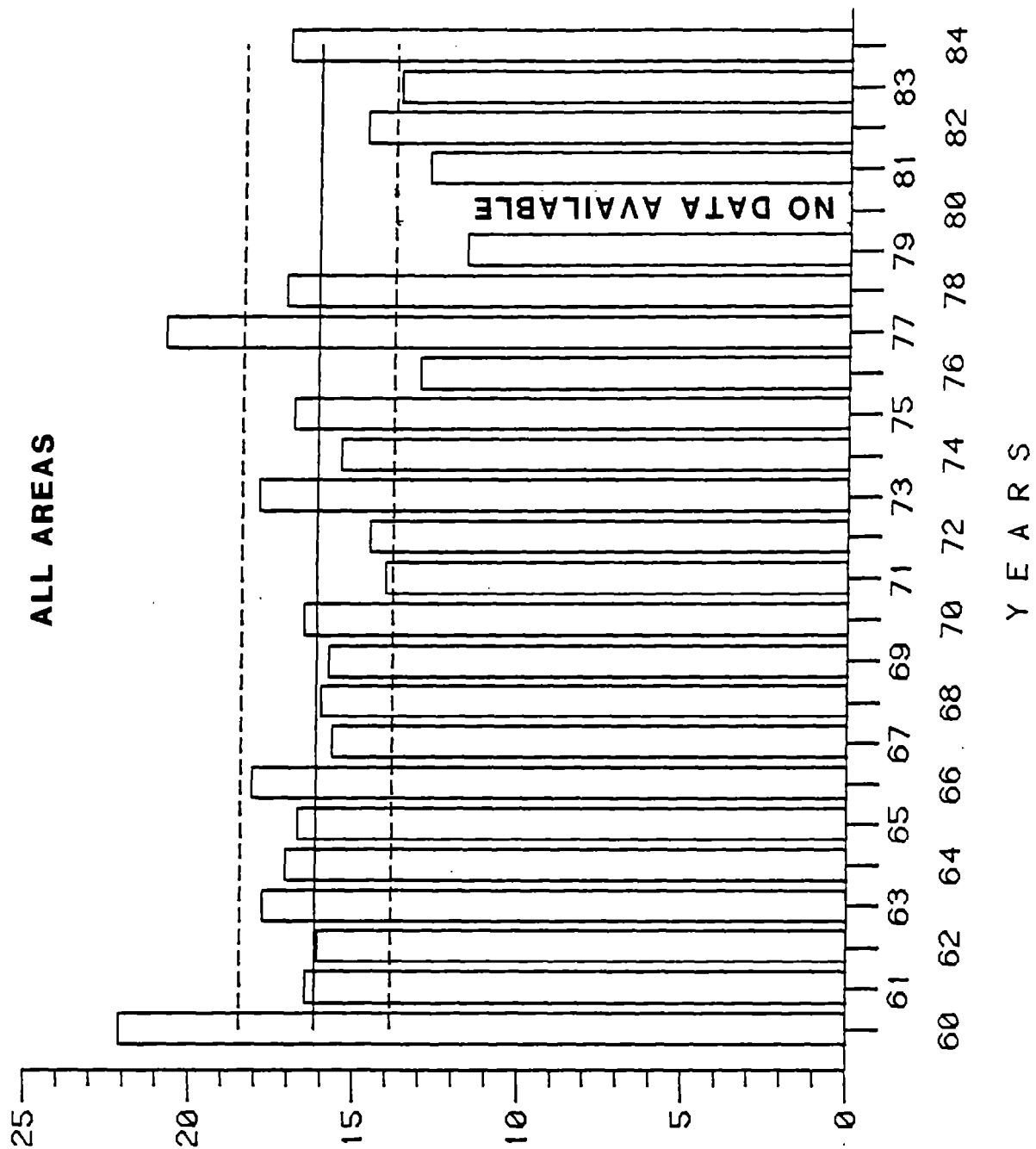


Figure 7. Pink shrimp fishery effort on the Tortugas grounds (subareas 1 through 3) for biological years 1960 through 1984. Solid line is the mean fishing effort and each broken line is one standard deviation from the mean.

TORTUGAS PINK SHRIMP  
SSA 2 ONLY

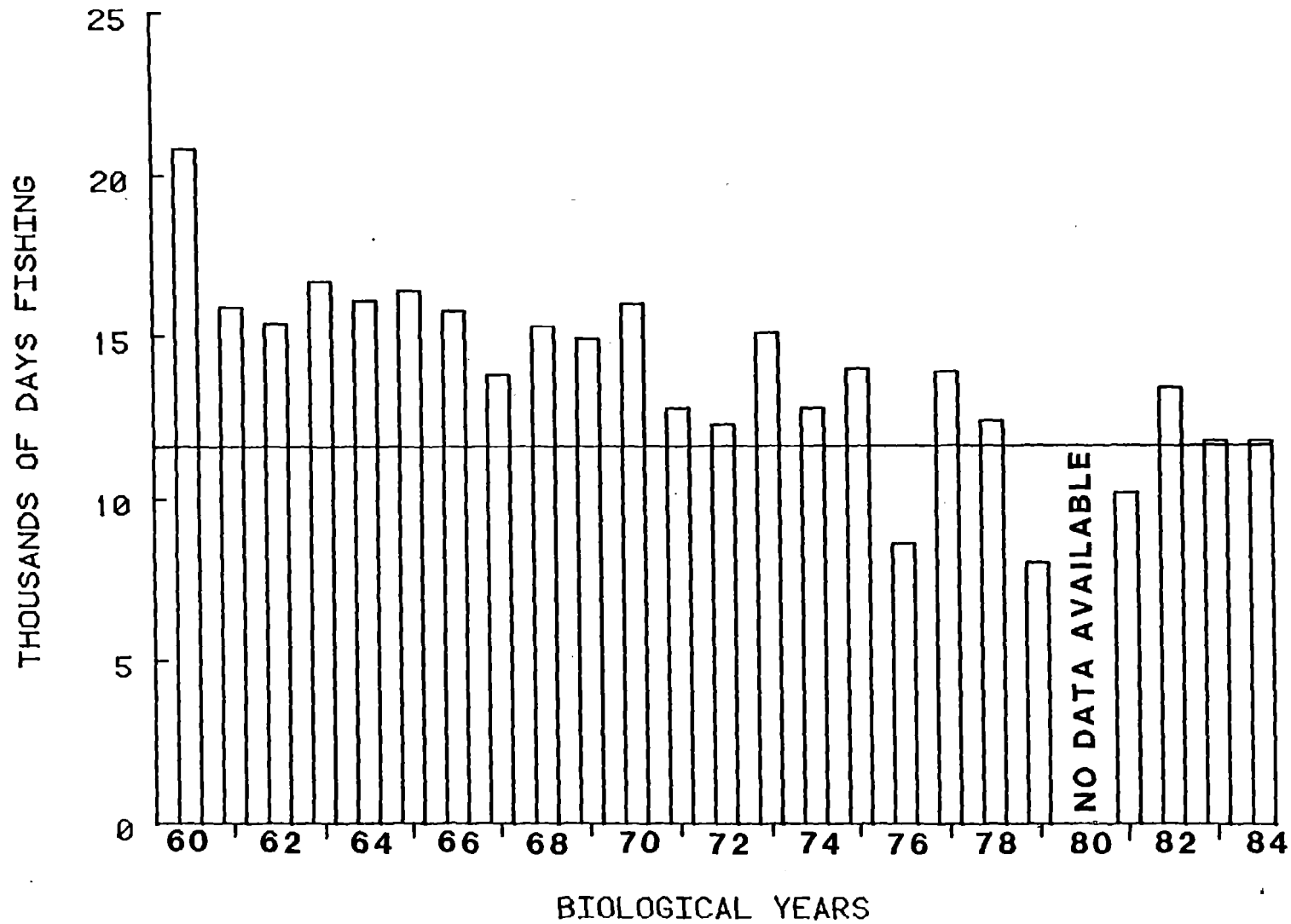


Figure 8. Pink shrimp, fishing effort (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean value.

TORTUGAS PINK SHRIMP  
SSA 3 ONLY

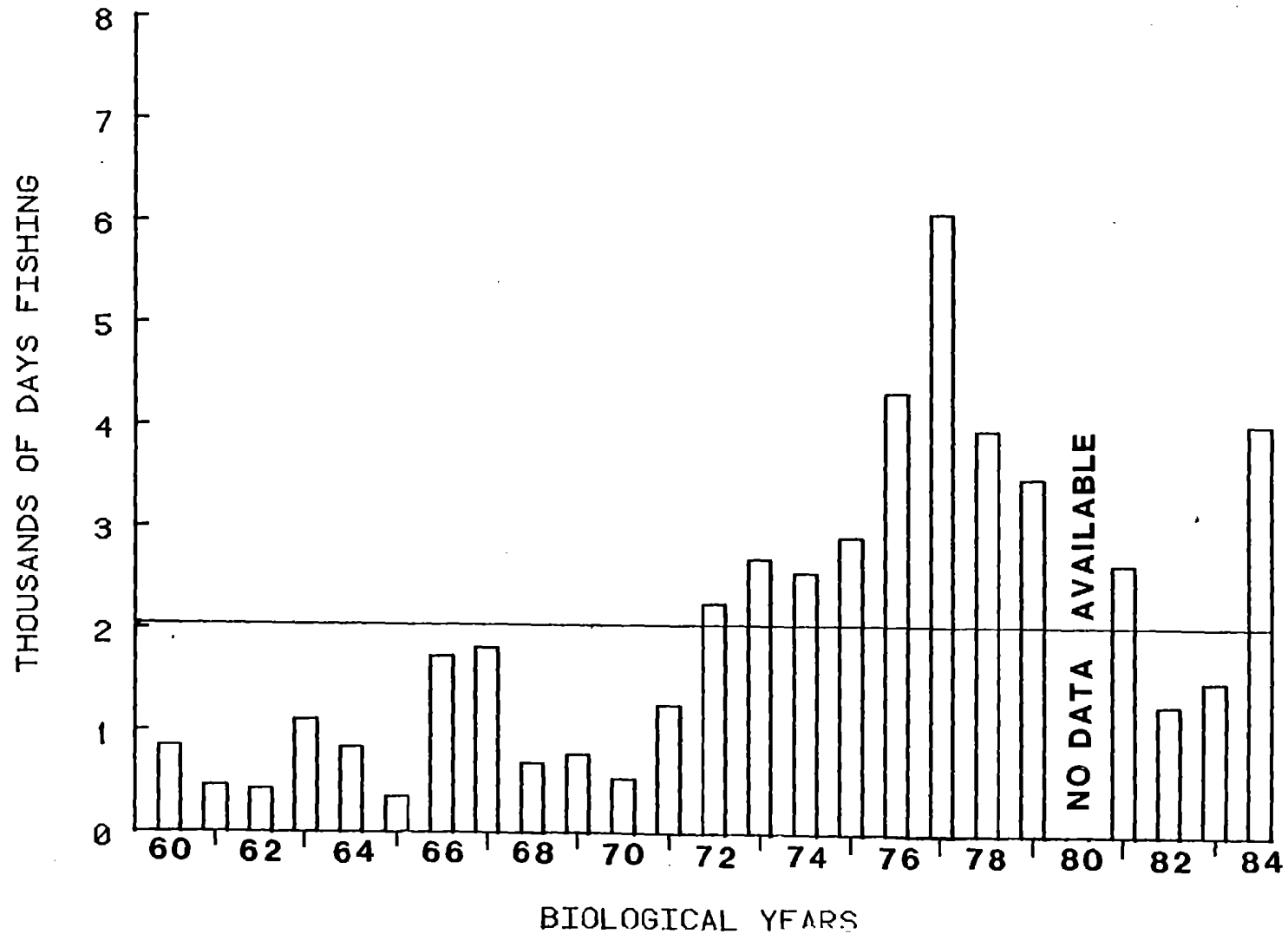


Figure 9. Pink shrimp fishing effort (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean value.

# PINK SHRIMP DATA

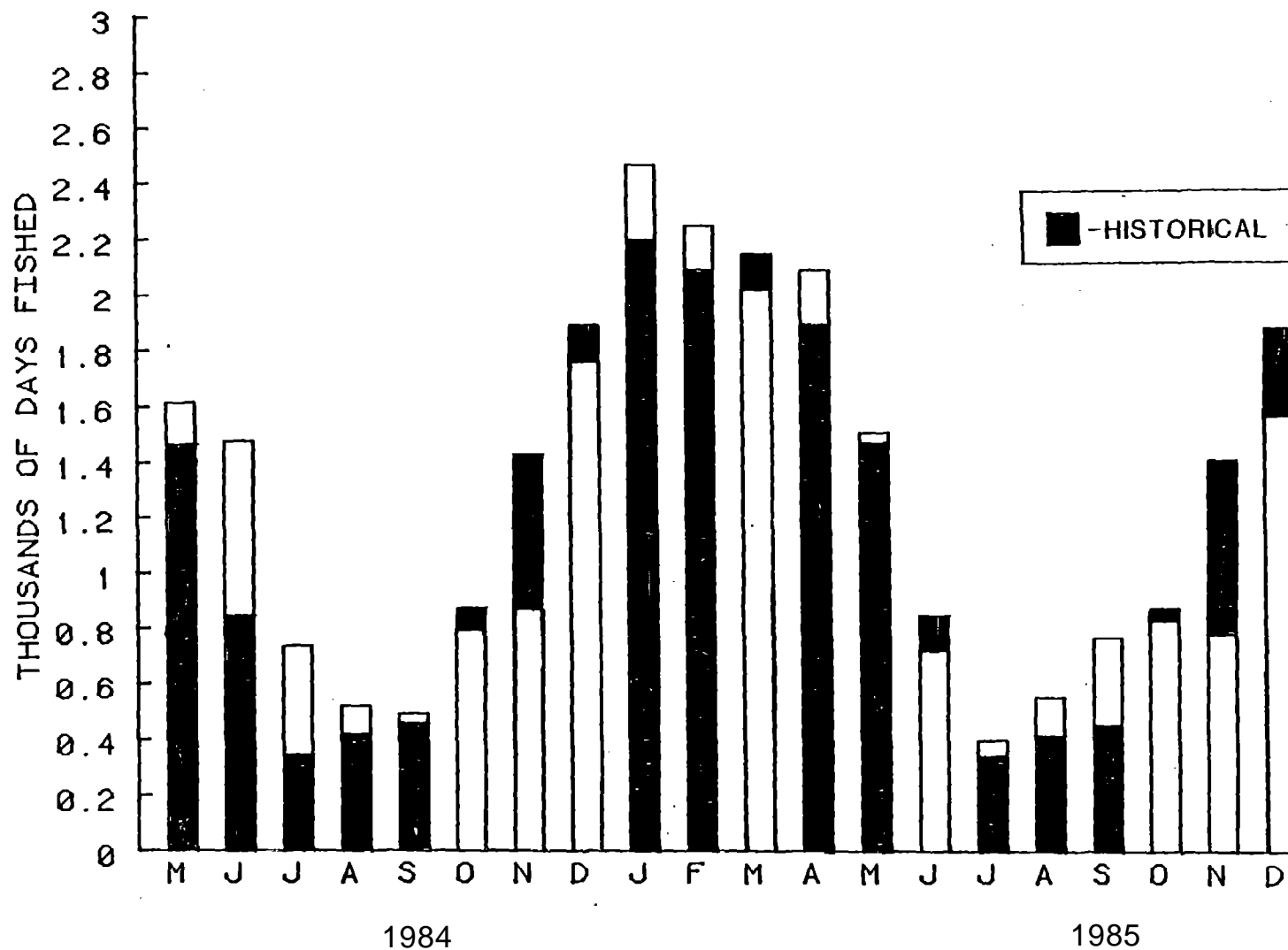


Figure 10. Average monthly historical effort compared to the monthly efforts for May 1984 through December 1985 from the Tortugas grounds.

TORTUGAS PINK SHRIMP  
SSA 2 ONLY

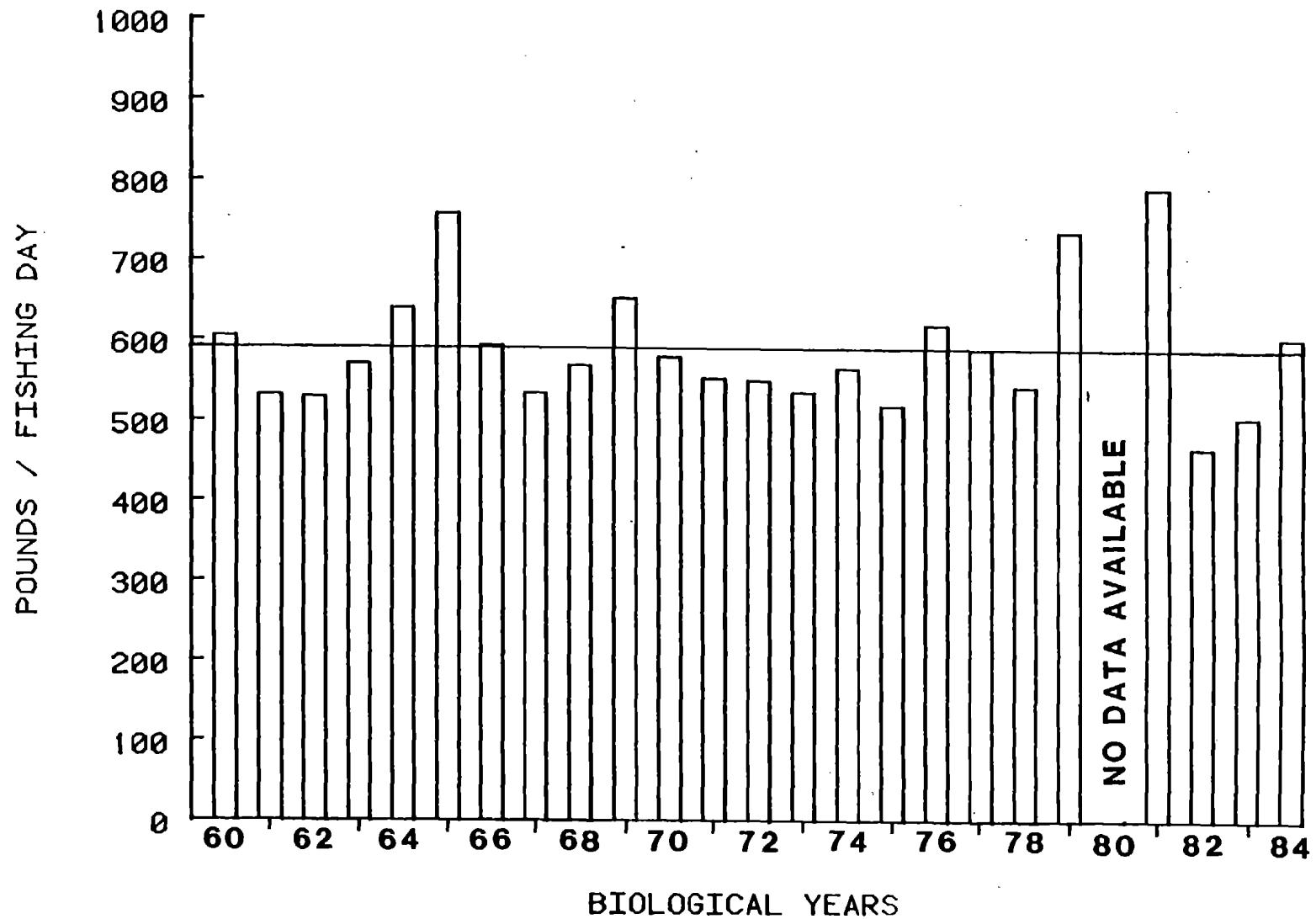


Figure 12. Pink shrimp CPUE (subarea 2) for biological years 1960 through 1984. Solid line is the historical mean value.

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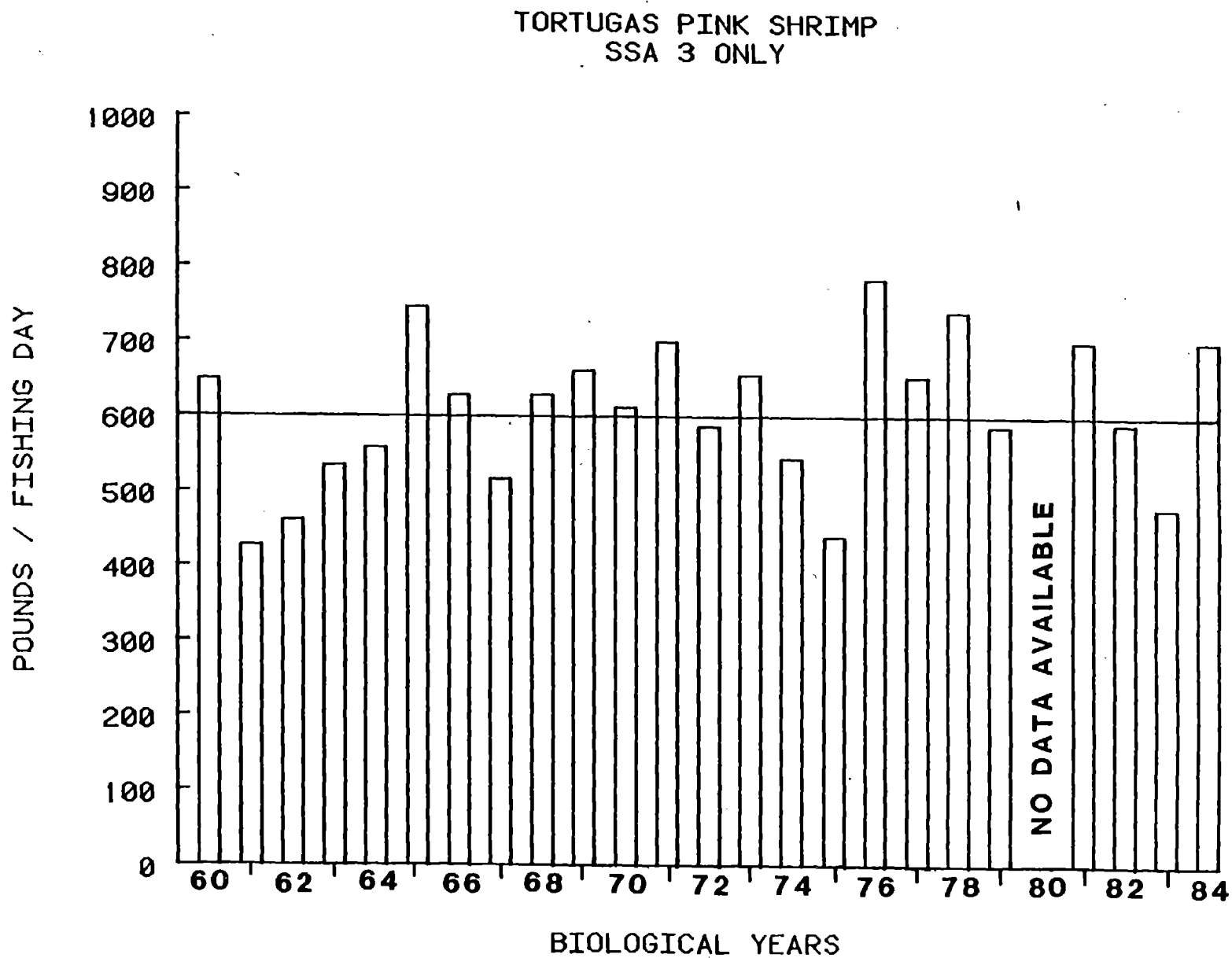


Figure 13. Pink shrimp CPUE (subarea 3) for biological years 1960 through 1984. Solid line is the historical mean value.

## PINK SHRIMP DATA

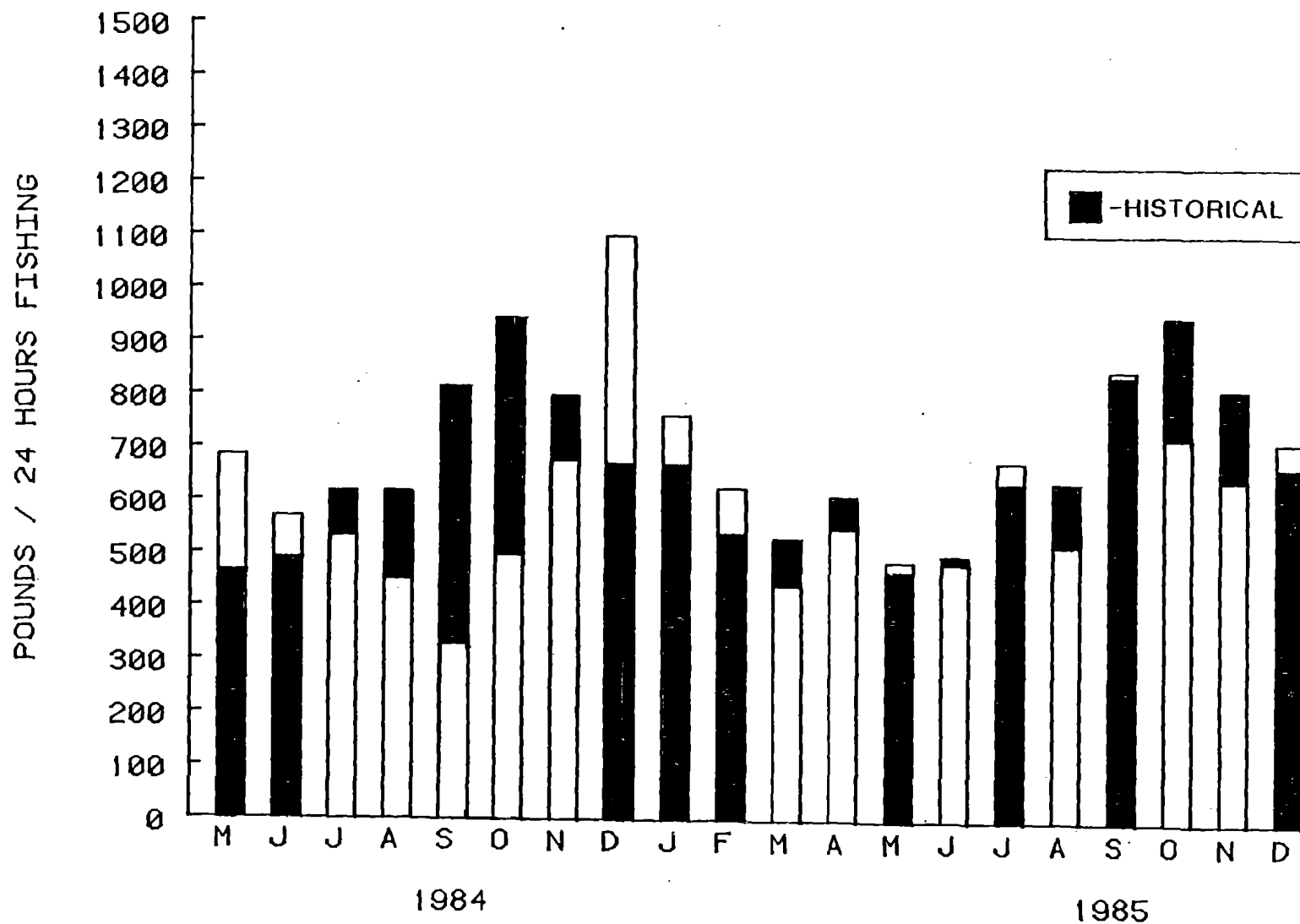


Figure 14. Average monthly historical CPUE values compared to the monthly CPUE values for May 1984 through December 1985 from the Tortugas grounds.

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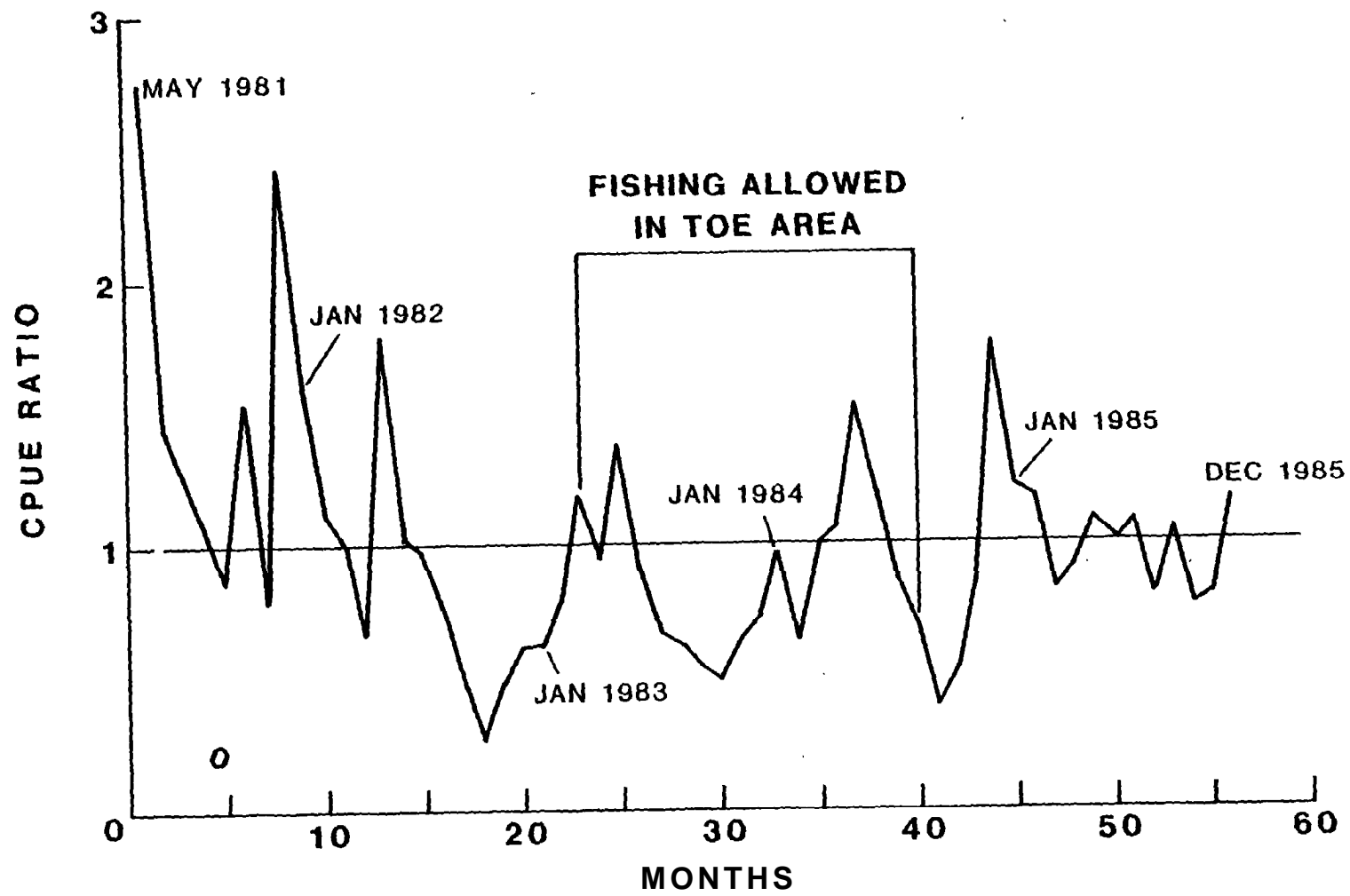


Figure 15. Ratios of monthly CPUE values from May 1981 through December 1985 compared with monthly historical CPUE values (1960) through 1979).



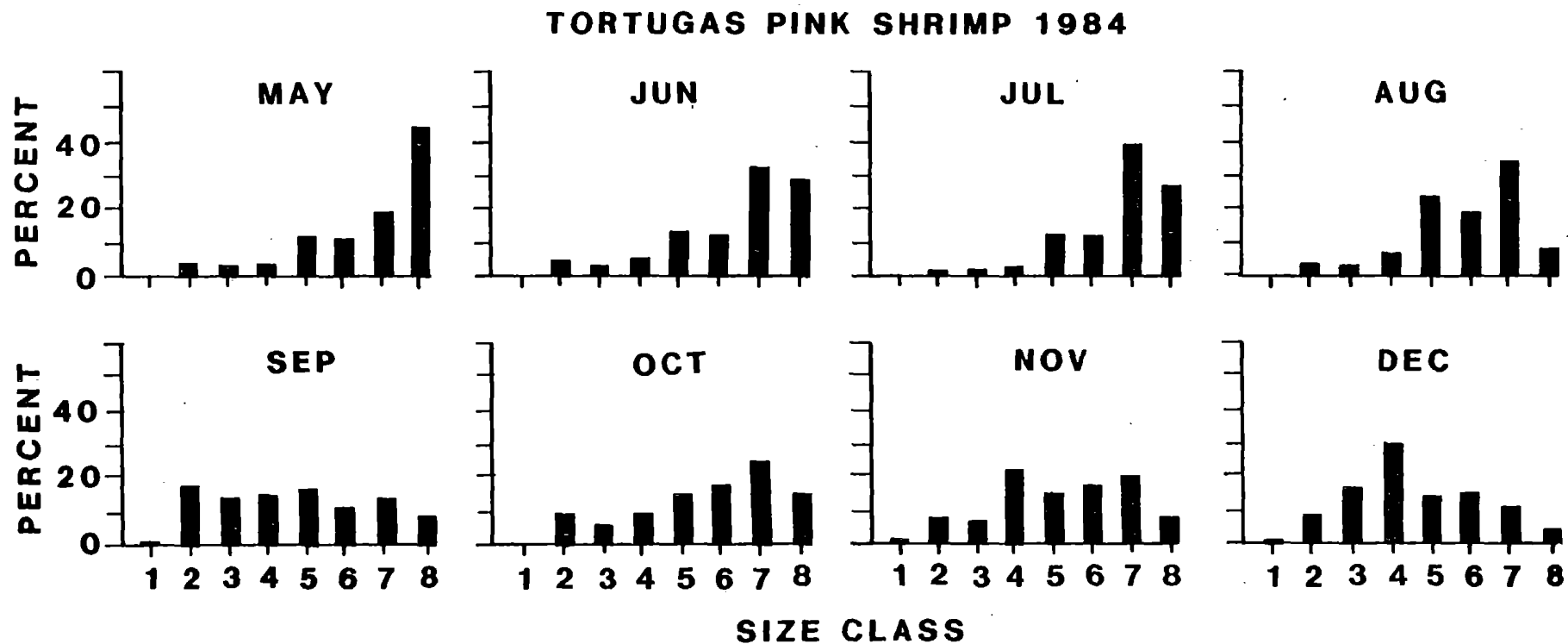


Figure 16. Percent composition of monthly pink shrimp size classes from the Tortugas fishery for May 1984 through December 1985.

# TORTUGAS PINK SHRIMP 1985

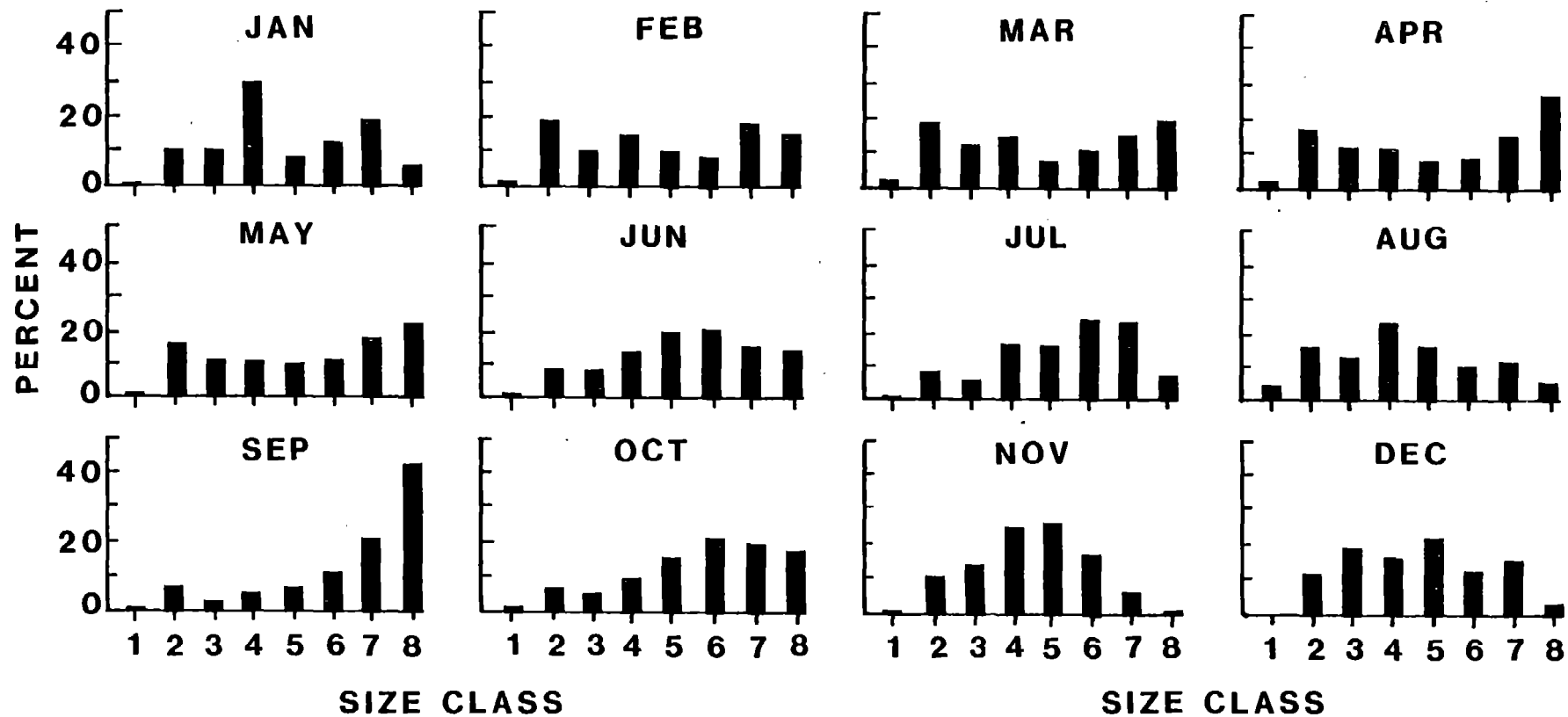


Figure 16 continued.

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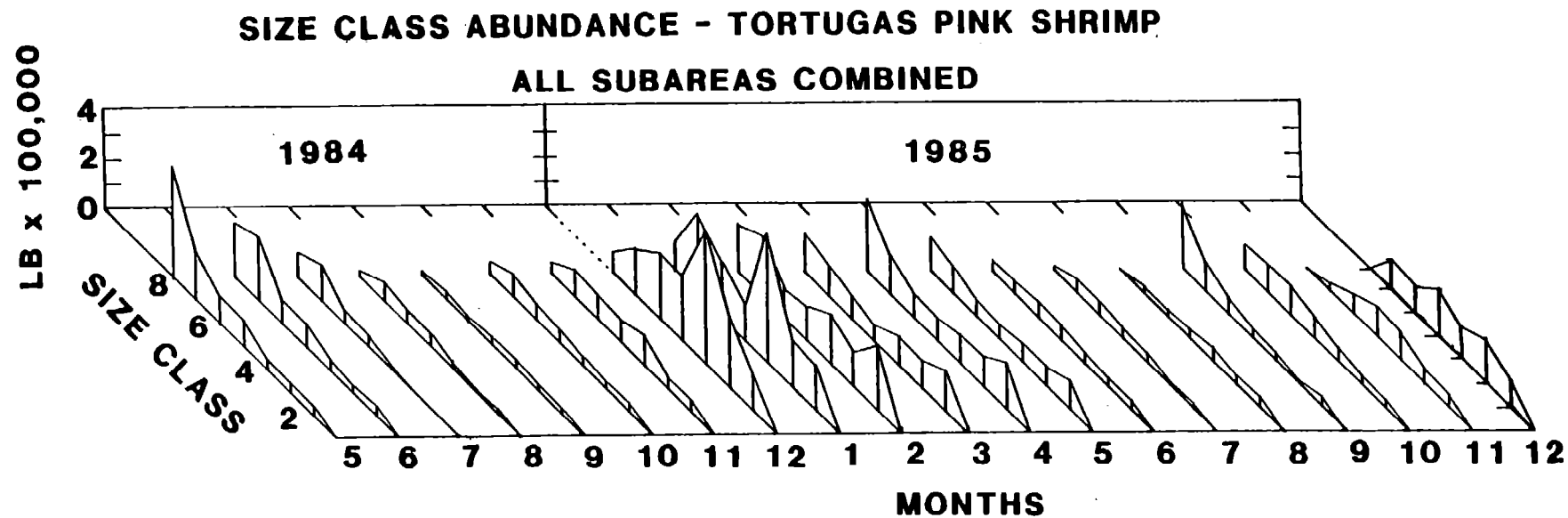


Figure 17. Total monthly catch by size classes from the Tortugas fishery (subareas 1 through 3) for May 1984 through December 1985.

# SIZE CLASS ABUNDANCE - TORTUGUS PINK SHRIMP

## STATISTICAL SUBAREA 1

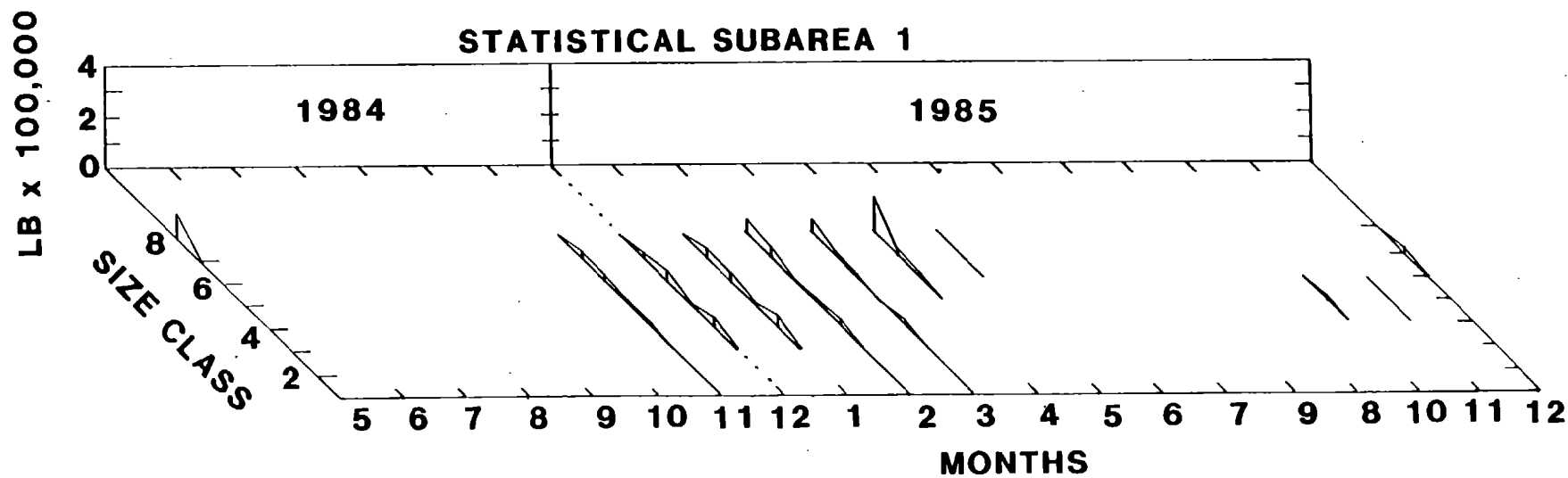


Figure 18. Total monthly catch by size classes (subarea 1) for May 1984 through December 1985.

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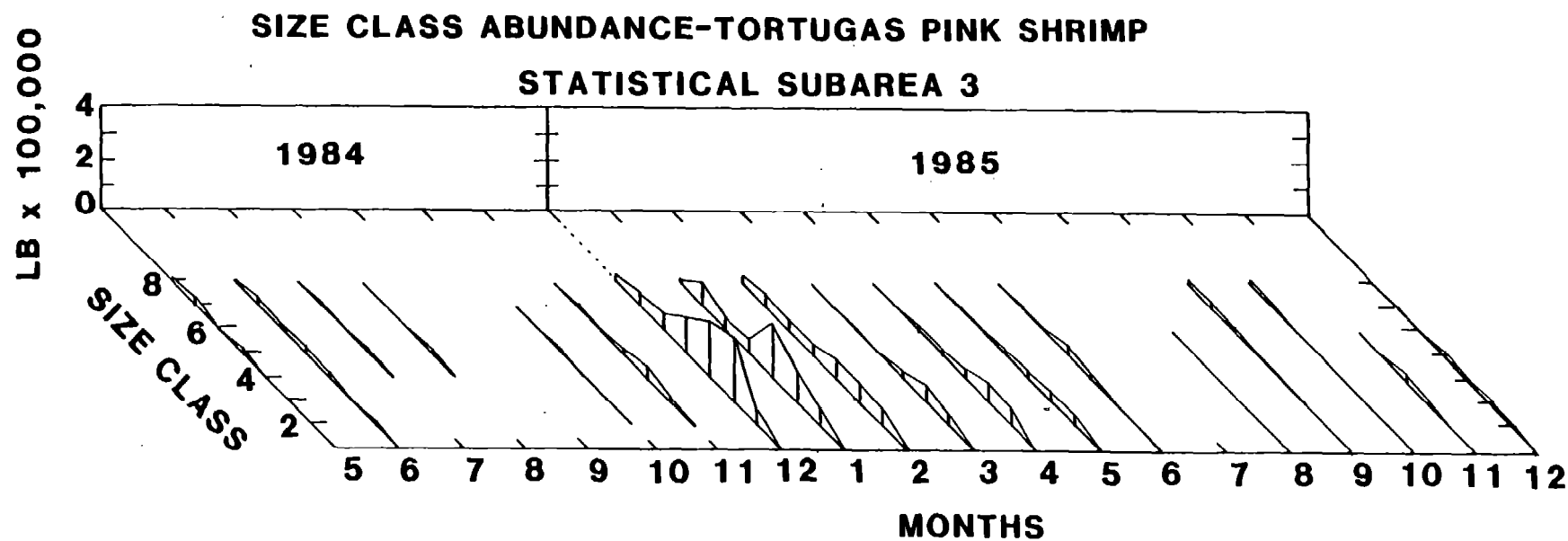


Figure 19. Total monthly catch by size classes (subarea 3) for May 1984 through December 1985.

47

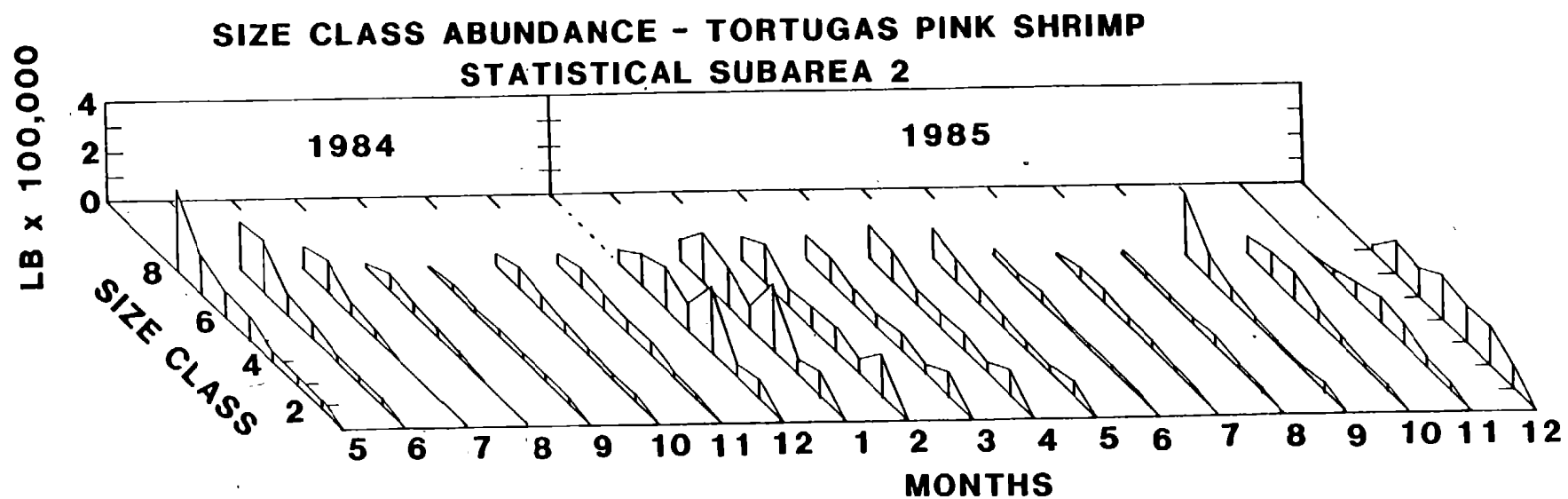


Figure 20. Total monthly catch by size classes (subarea 2) for May 1984 through December 1985.

TORTUGAS PINK SHRIMP  
ANALYST FILE

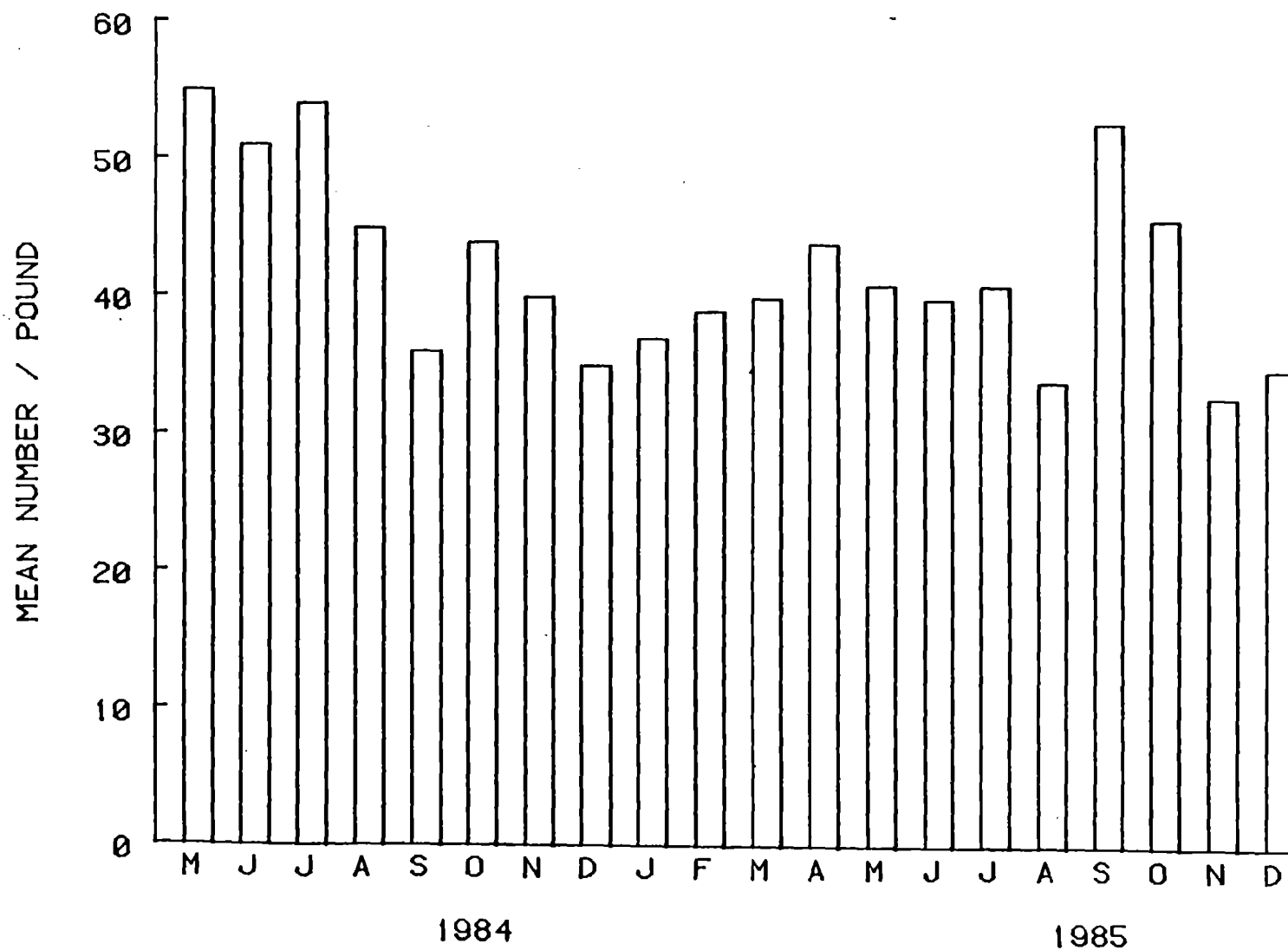


Figure 21. Mean number of pink shrimp per pound for a given month. Period covers biological year 1984 through the first 8 months of biological year 1985.

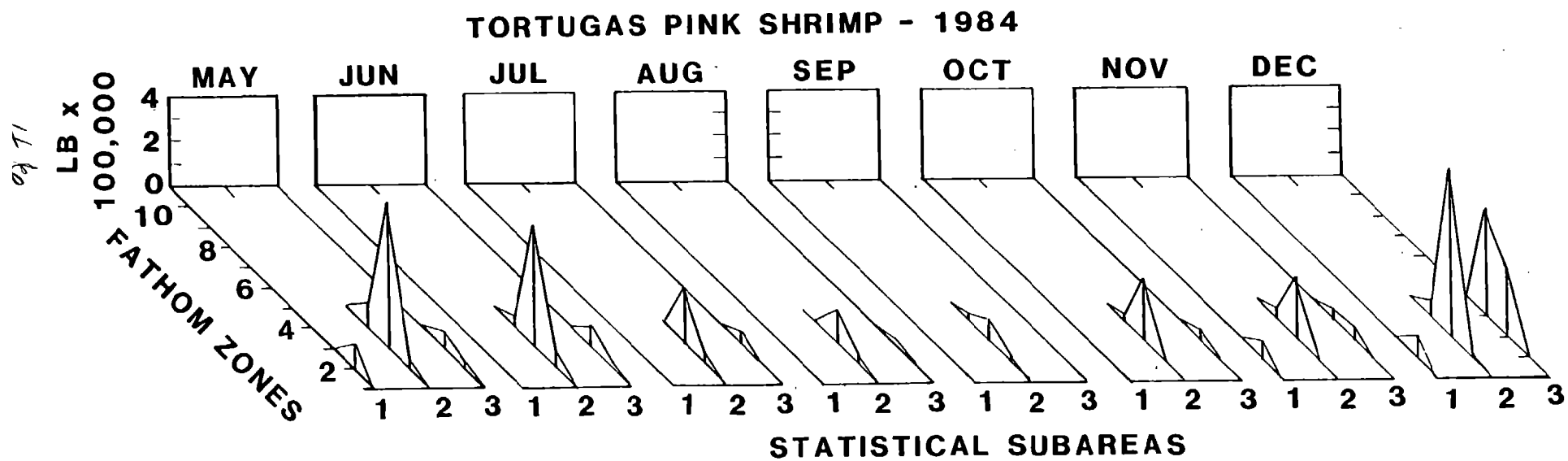


Figure 22. Pink shrimp catch by fathom zones for each statistical subarea (1 through 3) by month (May 1984 through December 1985).



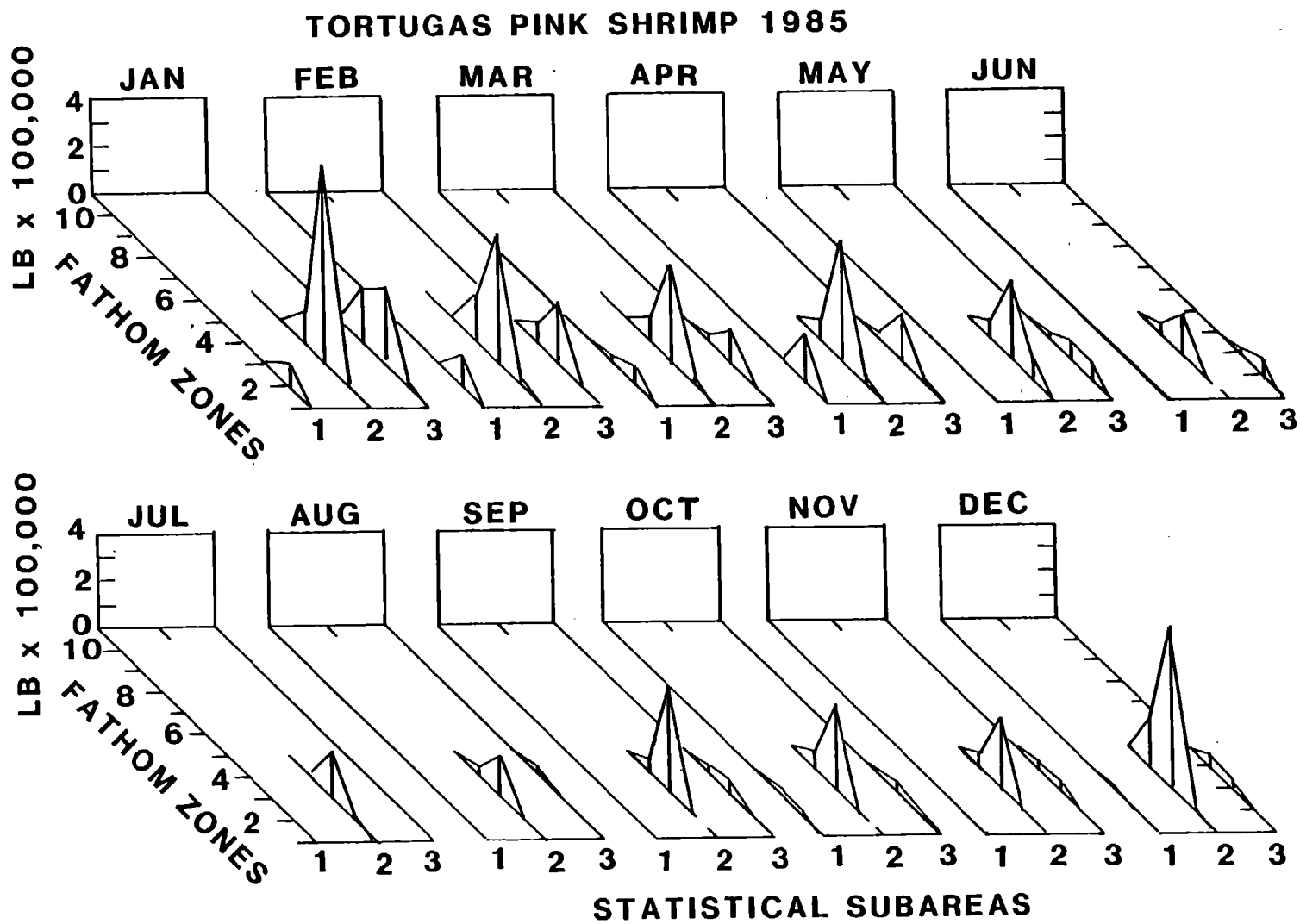


Figure 22 continued.

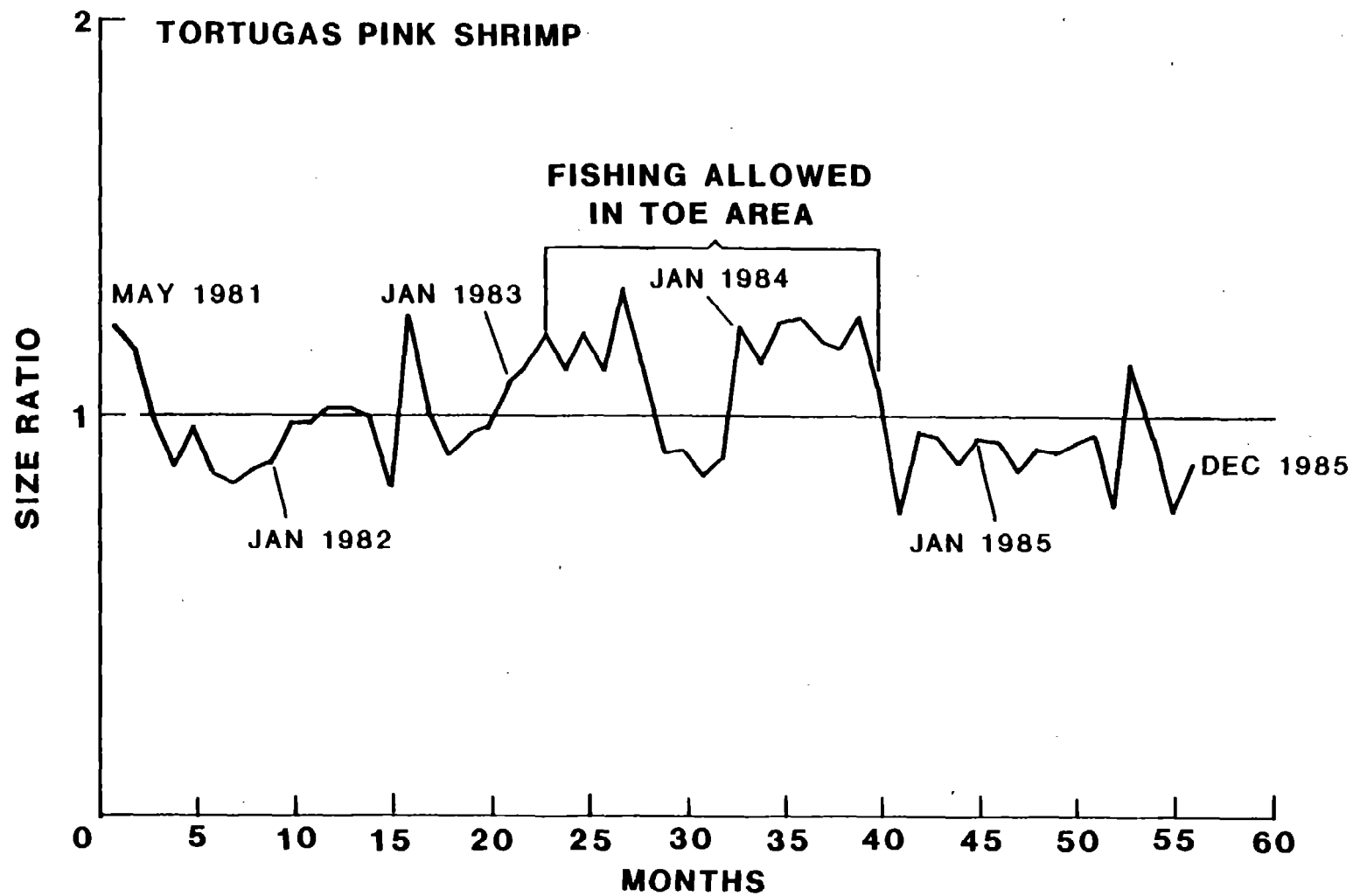


Figure 23. Ratios of monthly mean number of pink shrimp per pound from May 1981 through December 1985 to monthly historical mean number of pink shrimp per pound for 1960 through 1979.